mercruiser

SERVICE MANUAL

Number 16

MARINE ENGINES

GM V-8
454 CID (7.4L) / 502 CID (8.2L)

Book 1 of 2
Sections 1 thru 4

Printed in U.S.A.
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Notice

Throughout this publication, “Dangers,” “Warnings” and “Cautions” are used to alert the mechanic to special instructions concerning a particular service or operation that may be hazardous if performed incorrectly or carelessly. Observe them carefully!

These “Safety Alerts” alone cannot eliminate the hazards that they signal. Strict compliance to these special instructions when performing the service, plus “common sense” operation, are major accident prevention measures.

⚠ DANGER

DANGER - Immediate hazards which will result in severe personal injury or death.

⚠ WARNING

WARNING - Hazards or unsafe practices which could result in severe personal injury or death.

⚠ CAUTION

CAUTION - Hazards or unsafe practices which could result in minor personal injury or product or property damage.

Notice to Users of This Manual

This service manual has been written and published by the service department of Mercury Marine to aid our dealers, mechanics and company service personnel when servicing the products described herein.

It is assumed that these personnel are familiar with the servicing procedures of these products, of like or similar products manufactured and marketed by Mercury Marine, and that they have been trained in the recommended servicing procedures for these products which include the use of mechanic’s common hand tools and the special Mercury Marine or recommended tools from other suppliers.

We could not possibly know of and advise the service trade of all conceivable procedures by which a service might be performed and of the possible hazards and/or results of each method. We have not undertaken any such wide evaluation. Therefore, anyone who uses a service procedure and/or tool, which is not recommended by the manufacturer, first must completely satisfy himself that neither his nor the product’s safety will be endangered by the service procedure selected.

All information, illustrations and specifications contained in this manual are based on the latest product information available at time of publication.

It should be kept in mind, while working on the product, that the electrical system and ignition system are capable of violent and damaging short circuits or severe electrical shocks. When performing any work where electrical terminals could possibly be grounded or touched by the mechanic, the battery cables should be disconnected at the battery.

Any time the intake or exhaust openings are exposed during service they should be covered to protect against accidental entrance of foreign material which could enter the cylinders and cause extensive internal damage when the engine is started.

It is important to note that, during any maintenance procedure, replacement fasteners must have the same measurements and strength as those removed, whether metric or customary. Numbers on the heads of the metric bolts and on surfaces of metric nuts indicate their strength. Customary bolts use radial lines for this purpose, while most customary nuts do not have strength markings. Mismatched or incorrect fasteners can result in damage or malfunction, or possible personal injury. Therefore, fasteners removed should be saved for re-use in the same locations whenever possible. Where the fasteners are not satisfactory for re-use, care should be taken to select a replacement that meets the same specifications as the original.

Engine Mechanical Components

Many of the engine mechanical components are designed for marine applications. Unlike automotive engines, marine engines are subjected to extended periods of heavy load and wide-open-throttle operation and, therefore, require heavy-duty components. Special marine engine parts have design and manufacturing specifications which are required to provide long life and dependable performance. Marine engine parts also must be able to resist the corrosive action of salt or brackish water that will rust or corrode standard automotive parts within a short period of time.

Failure to use recommended Quicksilver service replacement parts can result in poor engine performance and/or durability, rapid corrosion of parts subjected to salt water and possibly complete failure of the engine.

Use of parts other than recommended service replacement parts, will void the warranty on those parts which are damaged as a result of the use of other than recommended replacement parts.

Replacement Parts

⚠ WARNING

Electrical, ignition and fuel system components on MerCruiser Engines and Stern Drives are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire or explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply to these rules and regulations, could result in a fire or explosion hazard and should be avoided.

When servicing the electrical, ignition and fuel systems, it is extremely important that all components are properly installed and tightened. If not, any electrical or ignition component opening would permit sparks to ignite fuel vapors from fuel system leaks, if they existed.

V-8 Models Covered in This Manual

Gen V Engines

Model	Serial Number
Stern Drive Engines	
MCM 7.4L Bravo	OD830779 to OF800699
MCM 7.4L Bravo Three	OD838819 to OF800699
MCM 7.4LX MPI	OF595275 to OF801999
MCM 454 Magnum (Carburetor)	OD837587 to OF801999
MCM 454 Magnum EFI, EFI/MP and MPI	OF111570 to OF802349
MCM 502 Magnum (Carburetor)	OD831432 to OF114528
MCM 502 Magnum EFI, EFI/MP, MPI	OD840650 to OF802599
Inboard Engines	
MIE 7.4L (Carburetor)	OD840300 to OF820141
MIE 7.4L EFI/MP and MPI	OF490697 to OF820103
MIE 8.2L (Carburetor)	OD857200 to OF819619
Ski Engines	
MIE 454 Magnum EFI, EFI/MP and MPI Tournament Ski	OF215800 to OF820099

Gen VI Engines

Model	Serial Number
Stern Drive Engines	
MCM Bravo 7.4L (Carburetor)	OF800700 and above
MCM 7.4LX EFI	OF820000 and above
MCM 7.4LX MPI	OF802000 and above
MCM 454 Magnum (Carburetor)	OF801700 and Above
MCM 454 MPI	OF802350 and above
MCM 502 MPI	OF802600 and above
Inboard Engines	
MIE 7.4L (Carburetor)	OF820142 and above
MIE 7.4L EFI	OF874815 and above
MIE 7.4L MPI	OF820104 and above
MIE 8.2L MPI	OF775694 and OF775695
MIE 8.2L MPI	OF819620 and above

Service Manual Outline

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- C - Troubleshooting

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- D - MIE Models - Hurth Transmissions

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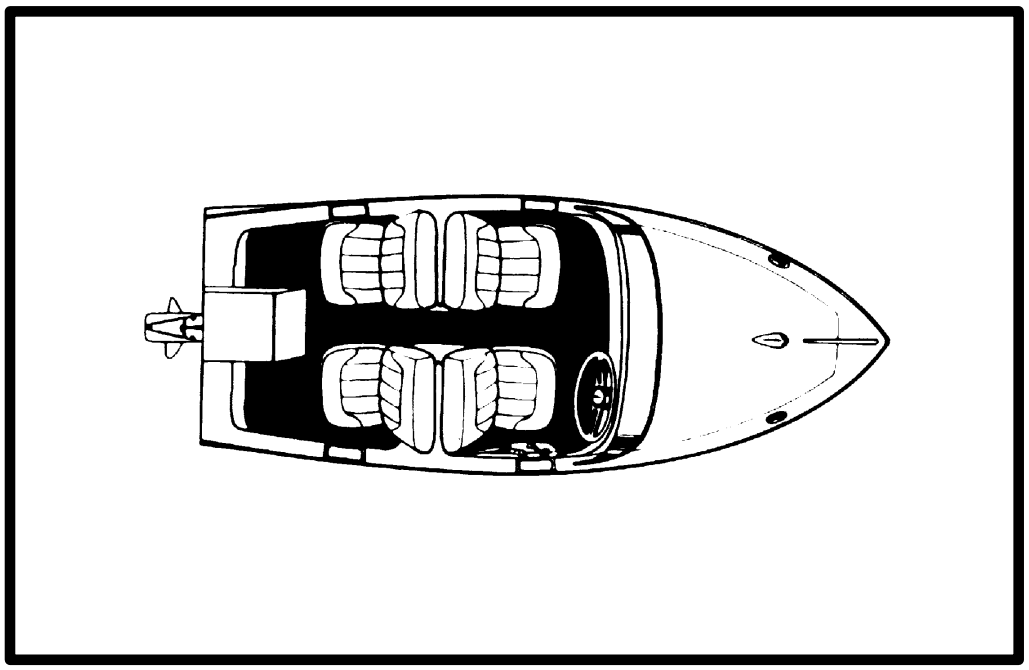
IMPORTANT INFORMATION

1

A



GENERAL INFORMATION

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Introduction

This comprehensive overhaul and repair manual is designed as a service guide for the models previously listed. It provides specific information, including procedures for disassembly, inspection, assembly and adjustment to enable dealers and service mechanics to repair and tune these engines.

Before attempting repairs or tune-up, it is suggested that the procedure first be read through to gain knowledge of the methods and tools used and the cautions and warnings required for safety.

How to Use This Manual

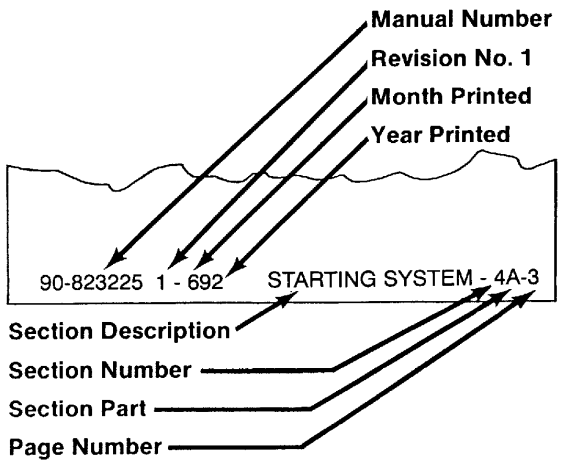
This manual is divided into sections which represent major components and systems.

Some sections are further divided into parts which more fully describe the component.

Sections and section parts are listed on the “Service Manual Outline” page following “V-8 Models Covered in This Manual” page.

Page Numbering

Two number groups appear at the bottom of each page. Following is an example and description.



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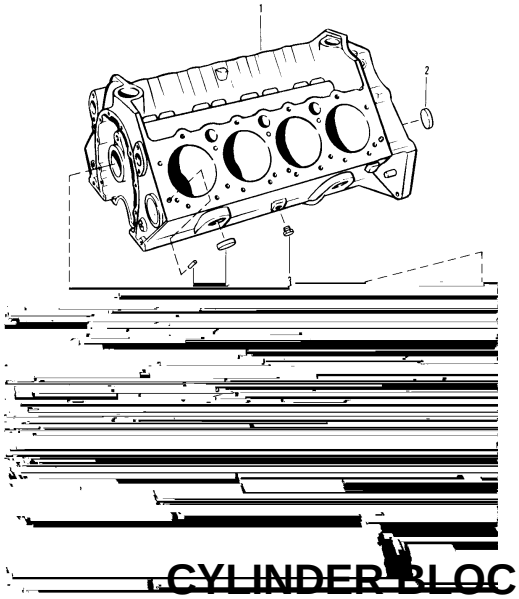
How To Read Parts Manual



CYLINDER BLOCK AND CAMSHAFT

M0033-**D8**

PART NO. (a)	REF. NO. (b)	DESCRIPTION (c)	QUAN. (d)
841-81631	1	CYLINDER BLOCK ASSEMBLY	1
N.S.S.	2	PLUG, expansion (1-1/4") (GM #3738306)	2
22-87238	3	DRAIN COCK, cylinder block	2
19-34270	4	PLUG, expansion - cylinder block (1-5/8" Diameter)	8
17-35465	5	PIN, dowel - block to head (5/16" Diameter)	4
22-72640	6	PLUG, expansion - camshaft bearing hole	1
23-85674	7	BEARING UNIT, camshaft (set)	1
72638	8	LIFTER, hydraulic valve	16
431-5943	9	CAMSHAFT	1
35378	10	CHAIN, camshaft timing	1
43-35338	11	SPROCKET, camshaft timing	1
43-48338	12	SPROCKET, crankshaft timing	1
10-34505	13	BOLT, camshaft timing sprockets (3/4")	3
12-39167	14	WASHER, camshaft timing sprocket bolt	3

(e) **841-8163 Cylinder Block Assembly includes only standard pistons, piston rings, crankshaft bearings and camshaft bearings.**

A. **Part Number:** For part ordering - Note N.S.S. for Reference Number 2, Plug, expansion - that means Not Sold Separately by Mercury Marine, however, in this case, the G.M. Part Number (for the plug) is given in the Description Column.
B. **Reference Number:** For part Shown on exploded parts view.
C. **Description:** This is the most important column because it gives:
1) Description of Part: Ref. No. 1 is a Cylinder Block Assembly, No. 9 is a Camshaft, etc.
2) What parts are included with a certain part: Notice how the Description of Part, for Ref. Nos. 1 and 8 thru 14, are at the left side of the column. Description of Part for Ref. Nos. 2 thru 7 are indented under "Cylinder Block Assembly". If Ref. No. 1 (Cylinder Block Assembly) was ordered, all indented parts (Ref. Nos 2thru 7) would come with the part. Ref. Nos. 8 thru 14 would not come with Ref. No. 1 and would have to be ordered separately. If 2 Cylinder Blocks were listed, both cylinder blocks would come with the indented parts. In some cases, an indented part will have another part indented under it. The second indented part will come with the first indented part.
3) Serial number break: If serial number information is listed, check product serial number to ensure that correct part is ordered.4) Special information: Many times special information will be shown after description such as; L.H. Rotation, R. H. Rotation, Filter up, Filter Down, etc. This will help in selecting the correct part.
D. **Quantity:** Quantity that has to be ordered.
E. **Special Information Block:** Additional information, part numbers for gasket sets, etc.

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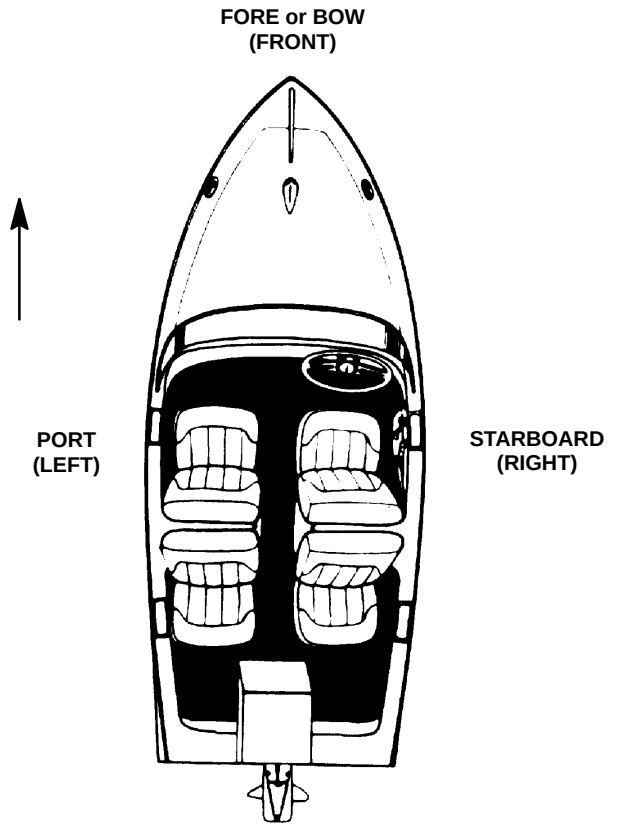
Directional References

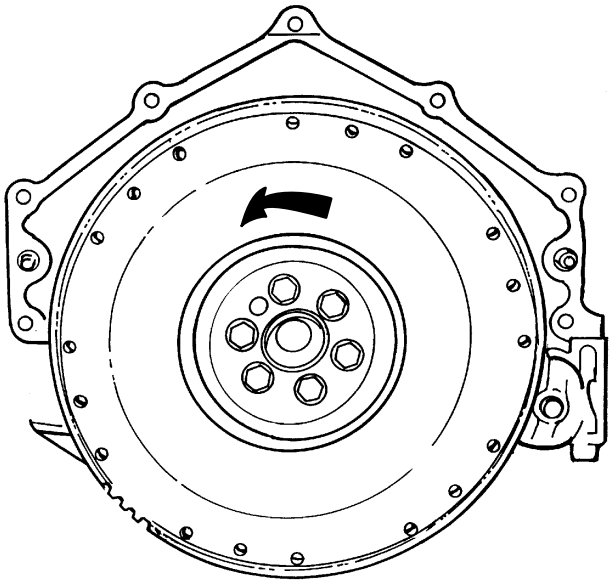
Front of boat is bow; rear is stern. Starboard side is right side; port side is left side. In this maintenance manual, all directional references are given as they appear when viewing boat from stern looking toward bow.



72000

Engine Rotation

Engine rotation is determined by observing flywheel rotation from the rear (stern end) of the engine looking forward (toward water pump end). Propeller rotation is not necessarily the same as engine rotation. When ordering replacement engine, short blocks or parts for engine, be certain to check engine rotation. Do not rely on propeller rotation in determining engine rotation.



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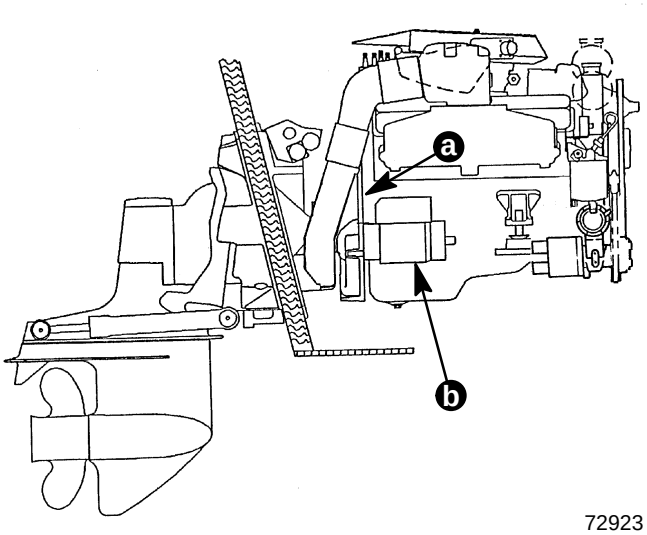
Standard Left-Hand Rotation

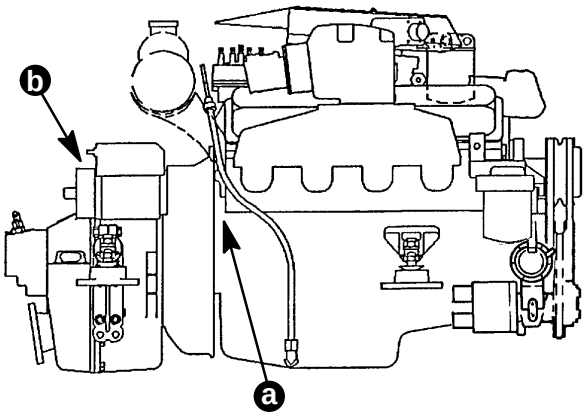
Engine Serial Number Locations



72923

Stern Drive (MCM)

a - Serial Number Plate
b - Starter Motor



72924

Inboard (MIE)

a - Serial Number Plate
b - Starter Motor

Propeller Information

Refer to the “Propeller” section in appropriate MerCruiser Stern Drive Service Manual, or order publication 90-86144-92, “Everything you need to know about propellers.”

Changing diameter, pitch or coupling of a propeller will affect engine RPM and boat performance. The blade configuration also will affect performance. Two like propellers, same pitch and diameter, from two different manufacturers also will perform differently.

It is the responsibility of the boat manufacturer and/or selling dealer to equip the boat with the correct propeller to allow the engine to operate within its specified RPM range at wide-open-throttle (W.O.T.).

Because of the many variables of boat design and operation, only testing will determine the best propeller for the particular application.

To test for correct propeller, operate boat (with an average load onboard) at W.O.T. and check RPM with an accurate tachometer. Engine RPM should be near top of the specified range so that, under heavy load, engine speed will not fall below specifications.

If engine exceeds the specified RPM, an increase in pitch and/or diameter is required.

If engine is below rated RPM, a decrease in pitch and/or diameter is required.

Normally, a change of approximately 150 RPM will be achieved for each single inch of pitch change of a propeller.

⚠CAUTION

If a propeller is installed that does not allow engine RPM to reach the specified full-throttle RPM range, the engine will “labor” and will not produce full power. Operation under this condition will cause excessive fuel consumption, engine overheating and possible piston damage (due to detonation). On the other hand, installation of a propeller, that allows engine to run above the specified RPM limit, will cause excessive wear on internal engine parts which will lead to premature engine failure.

Water Testing New Engines

Use care during the first 20 hours of operation on new MerCruiser engines or possible engine failure may occur. If a new engine has to be water-tested at full throttle before the break-in period is complete, follow this procedure.

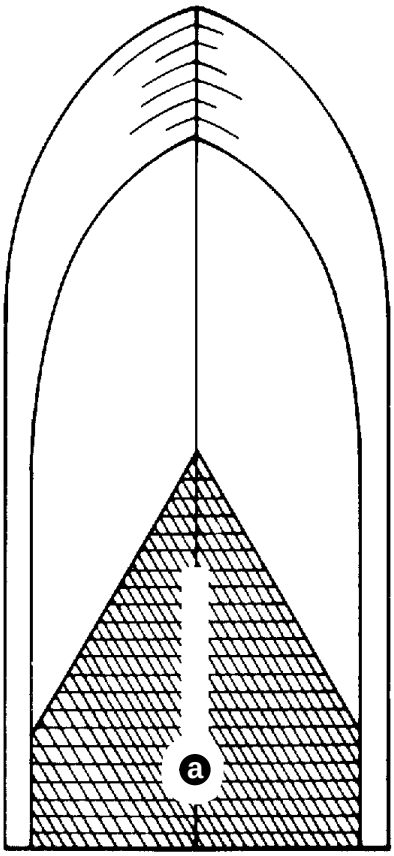
1. Start engine and run at idle RPM until normal operating temperature is reached.
2. Run boat up on plane.
3. Advance engine RPM (in 200 RPM increments) until engine reaches its maximum rated RPM.

IMPORTANT: Do not run at maximum RPM for more than 2 minutes.

Boat and Engine Performance

Boat Bottom

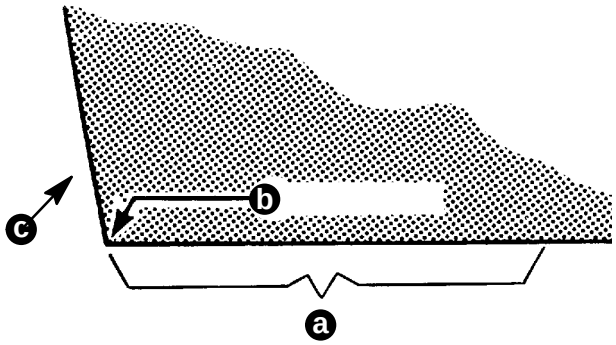
For maximum speed, a boat bottom should be as flat as possible in a fore-aft direction (longitudinally) for approximately the last 5 ft. (1.5 m).



72002

a - Critical Bottom Area

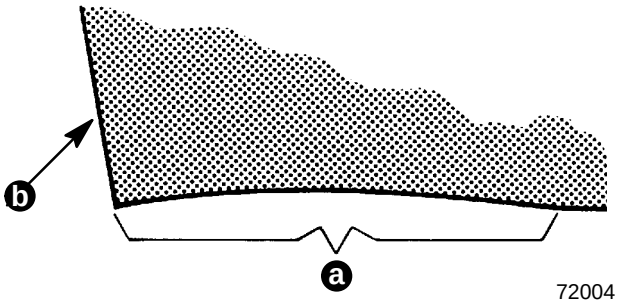
For best speed and minimum spray, the corner between the bottom and the transom should be sharp.



72003

a - Flat
b - Sharp Corner
c - Transom

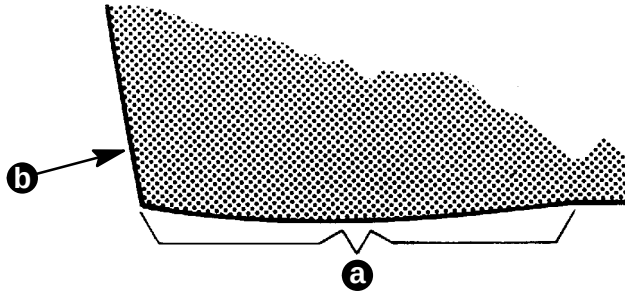
The bottom is referred to as having a “hook” if it is concave in the fore-and-aft direction. A hook causes more lift on the bottom near the transom and forces the bow to drop. This increases wetted surface and reduces boat speed. A hook, however, aids in planing and reduces any porpoising (rhythmical bouncing) tendency. A slight hook is often built in by the manufacturer. A hook also can be caused by incorrect trailering or storing the boat with support directly under the transom.



72004

a - Hook
b - Transom

A “rocker” is the reverse of a hook. The bottom is convex or bulged in the fore-and-aft direction. It can cause the boat to porpoise.



72005

a - Rocker
b - Transom

Any hook, rocker or surface roughness on the bottom, particularly in the all-important center-aft portion will have a negative effect on speed, often several miles per hour on a fast boat.

Marine Fouling

Fouling is an unwanted build-up (usually animal-vegetable-derived) occurring on the boat’s bottom and drive unit. Fouling adds up to drag, which reduces boat performance. In fresh water, fouling results from dirt, vegetable matter, algae or slime, chemicals, minerals and other pollutants. In salt water, barnacles, moss and other marine growth often produce dramatic build-up of material quickly. Therefore, it is important to keep the hull as clean as possible in all water conditions to maximize boat performance.

Antifouling paint, if required, may be applied to boat hull observing the following precautions.

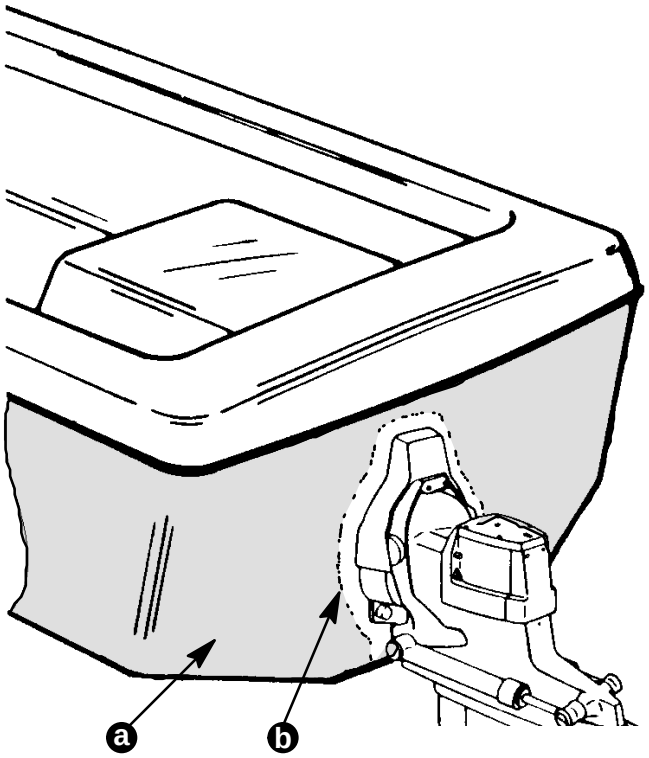
IMPORTANT: DO NOT paint anodes or MerCathode System reference electrode and anode, as this will render them ineffective as galvanic corrosion inhibitors.

⚠CAUTION

Avoid corrosion damage. Do not apply antifouling paint to MerCruiser drive unit or transom assembly.

IMPORTANT: If antifouling protection is required, Tri-Butyl-Tin-Adipate (TBTA) base antifouling paints are recommended on MerCruiser boating applications. In areas where Tri-Butyl-Tin-Adipate base paints are prohibited by law, copper base paints can be used on boat hull and boat transom. Corrosion damage that results from the improper application of antifouling paint will not be covered by the limited warranty. Observe the following:

Avoid an electrical interconnection between the MerCruiser Product, Anodic Blocks, or MerCathode System and the paint by allowing a minimum of 1 in. (26mm) UNPAINTED area on transom of the boat around these items.



71176

a - Antifouling Paint
b - MINIMUM 1 Inch (26 mm) UNPAINTED Area

Weight Distribution

Weight distribution is extremely important; it affects a boat’s running angle or attitude. For best top speed, all movable weight - cargo and passengers - should be as far aft as possible to allow the bow to come up to a more efficient angle (3 to 5 degrees). On the negative side of this approach is the problem that, as weight is moved aft, some boats will begin an unacceptable porpoise.

Secondly, as weight is moved aft, getting on plane becomes more difficult.

Finally, the ride in choppy water becomes more uncomfortable as the weight goes aft. With these factors in mind, each boater should seek out what weight locations best suit his/her needs.

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Weight and passenger loading placed well forward increases the “wetted area” of the boat bottom and, in some cases, virtually destroys the good performance and handling characteristics of the boat. Operation in this configuration can produce an extremely wet ride, from wind-blown spray, and could even be unsafe in certain weather conditions or where bow steering may occur.

Weight distribution is not confined strictly to fore and aft locations, but also applies to lateral weight distribution. Uneven weight concentration to port or starboard of the longitudinal centerline can produce a severe listing attitude that can adversely affect the boat’s performance, handling ability and riding comfort. In extreme rough water conditions, the safety of the boat and passengers may be in jeopardy.

Water in Boat

When a boat loses performance, check bilge for water. Water can add considerable weight to the boat, thereby decreasing the performance and handling.

Make certain that all drain passages are open for complete draining.

Elevation and Climate

Elevation has a very noticeable effect on the wide-open- throttle power of an engine. Since air (containing oxygen) gets thinner as elevation increases, the engine begins to starve for air. Humidity, barometric pressure and temperature do have a noticeable effect on the density of air. Heat and humidity thin the air. This phenomenon can become particularly annoying when an engine is propped out on a cool dry day in spring and later, on a hot, sultry day in August, doesn’t have its old zip.

Although some performance can be regained by dropping to a lower pitch propeller, the basic problem still exists. The propeller is too large in diameter for the reduced power output. The experienced marine dealer or a Quicksilver Propeller Repair Station can determine how much diameter to remove from a lower-pitch propeller for specific high-elevation locations. In some cases, a gear-ratio change to the drive unit to more reduction is possible and very beneficial. It is a known fact that weather conditions exert a profound effect on power output of internal combustion engines. Therefore, established horsepower ratings refer to the power that the engine will produce at its rated RPM under a specific combination of weather conditions.

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IMPORTANT INFORMATION

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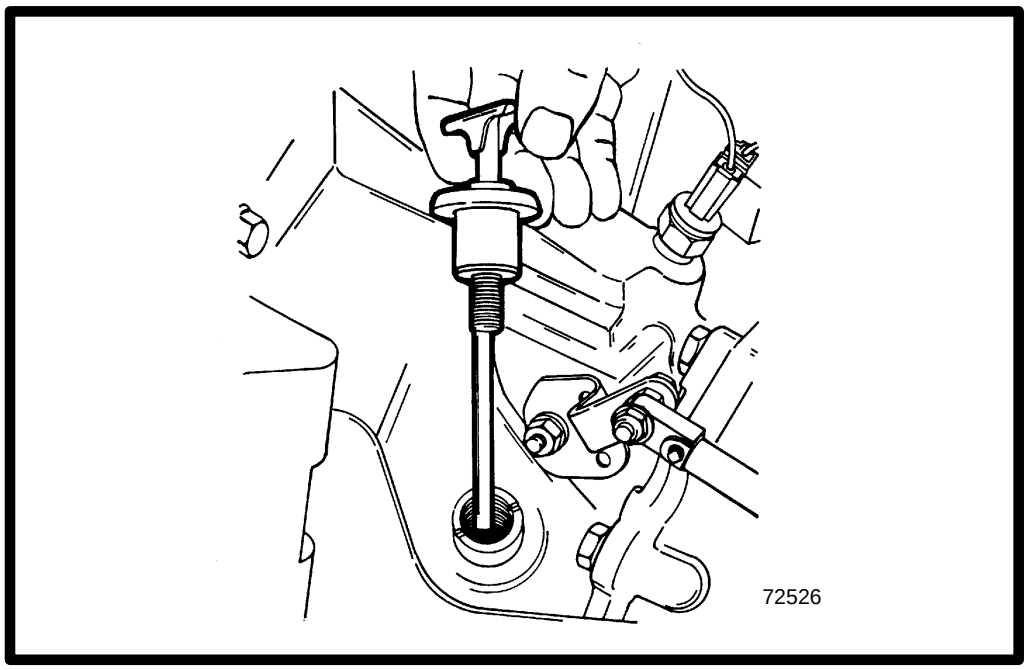

MAINTENANCE

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Maintenance Schedule

Maintenance Intervals

Maintenance intervals and the tasks to be performed, as shown in this current schedule, or as found in a previously printed schedules, are generally based on an average boating application and environment. However, individual operating habits and personal maintenance preferences can have an impact on the suggested intervals. In consideration of these factors, MerCruiser has adjusted some maintenance intervals and corresponding tasks to be performed. In some cases, this may allow for more individual tasks to be performed in a single visit to the serving dealer, rather than multiple visits. Therefore, it is very important that the boat owner and servicing dealer discuss the current Maintenance Schedule and develop appropriate maintenance intervals to coincide with the individual operating habits, environment, and maintenance requirements.

Always disconnect battery cables from battery BEFORE working around electrical systems components to prevent injury to yourself and damage to electrical system should a wire be accidentally shorted.

SCHEDULED MAINTENANCE THAT CAN BE PERFORMED BY OWNER/OPERATOR

NOTE: *Only perform maintenance which applies to your particular power package.*

Task	Interval
Engine Crankcase Oil - Check level	Weekly
Closed Cooling Coolant - Check level	
Power Steering Fluid - Check level	
Stern Drive Unit Oil - Check level	
Battery - Check level and inspect for damage	
Fuel Pump Sight Tube (If Equipped) - Check that no fuel is present	
Power Trim Pump Oil - Check level	
Anodes - Inspect for erosion	
Gear Housing Water Pickups - Check for marine growth or debris	
Drive Belt(s) - Inspect condition and check tension	Every 100 hours of operation or 120 days. Whichever occurs first.
Propeller Shaft - Lubricate	**Saltwater Use**: Every 50 hours of operation or 60 days, Whichever occurs first. **Freshwater Use:** Every 100 hours of operation or 120 days, Whichever occurs first.
Power Package - Exterior Surfaces - Spray with rust preventative	
Power Package Exterior Surfaces - Clean and paint	Once a year
Cooling System - Flush seawater section	**Saltwater Use:** After every use.

Maintenance Schedule (Continued)

To Be Done by Dealer

NOTE: *Only perform maintenance which applies to your particular power package.*

Task	Interval
Seawater Pickup Pump - Disassemble and inspect	Whenever insufficient seawater flow is suspected. (If operating temperature exceeds normal range.)
Crankcase Oil and Filter Change	End of first boating season and thereafter, every100 hours of operation or once yearly, whichever occurs first.
Ignition system - Clean and Inspect condition.	
Flame Arrestor and Crankcase Ventilation Hose - Clean and Inspect.	
Positive Crankcase Ventilation (PCV) Valve (If So Equipped) - Change	
Stern Drive unit Oil - Change	
Gimbal Ring Clamping Screws - Retorque to 40 ft. lb. (54 N·m)	
Rear Engine Mounts - Check torque to 30-40 ft. lb. (47-54 N·m)	
Gimbal Bearing - Lubricate	
Cooling System - Clean and Inspect	
Engine Alignment - Check	
Engine Coupling Universal Joint Shaft Splines - Lubricate	
Steering System - Lubricate and inspect for loose, damage or missing parts.	
Electrical System - Check for loose or damaged wiring.	
Cooling System Hoses and Clamps - Inspect for damage and deterioration. Check Clamps for tightness.	
Closed Cooling System Pressure Cap - Clean, inspect and test .	
Continuity Circuit - Check components for loose connections, broken or frayed wires.	
Shift and Throttle Cable and Linkage - Lubricate and inspect for loose, damaged or missing parts	
Engine Exhaust System - Inspect externally for damage, deterioration and restrictions. Check for tightness.	
Ignition System - Check Timing and adjust as needed.	

Maintenance Schedule (Continued)

To Be Done by Dealer

NOTE: *Only perform maintenance which applies to your particular power package.*

Task	Interval
Steering Head and Remote Control - Inspect and Lubricate.	End of first boating season and thereafter, every 100 hours of operation or once yearly, whichever occurs first.
Carburetor (If So Equipped) - Inspect and adjust.	
Throttle Body (Fuel Injection Models) - Inspect	
Fuel Filters - Replace	Once a Year
Quicksilver Mercathode System - Test output.	
Closed Cooling Coolant - Test for Alkalinity	
Heat Exchanger - Clean seawater section.	
Drive Unit Bellows and Clamps - Inspect	
Universal Joint Cross Bearings- Inspect	End of first boating season and thereafter, every 200 hours of operation or once yearly, whichever occurs first.
Closed Cooling Coolant - Replace	Every Two Years

Tune-Up Specifications

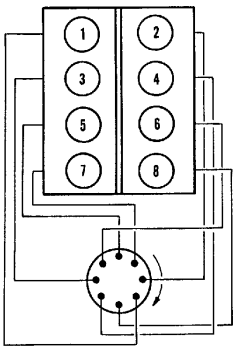
MCM (Stern Drive)

Model	MCM 7.4L	MCM 7.4L PT Bravo Three	MCM 454 Magnum	MCM 454 EFI	MCM 502 Magnum	MCM 502 EFI Magnum
Propshaft Ratings HP (KW)	300 (224)	300 (224)	350 (261)	385 (287)	390 (291)	415 (309)
Number of Cylinders	V-8					
Displacement	454 C.I.D (7.4L)				502 C.I.D. (8.2L)	
Bore/Stroke In. (mm)	4.25x4.00 (108x101.6)				4.47 x 4.00 (113.5 x 101.6)	
Compression Ratio	8.0:1		8.6:1			
Compression Pressure	150 PSI (1034 kPa)					
Idle RPM (in Forward Gear)	650			600	650	600
Max. RPM (at W.O.T.)	4200-4600		4600-5000			
Oil Pressure (at 2000 RPM)	30-70 PSI (207-483 kPa)					
Min. Oil Pressure (at Idle)	4 PSI (28 kPa)					
Fuel Pump Pressure (at 1800 RPM)	3-7 PSI (21-48 kPa)					
Fuel Rail Pressure (Running) (E.F.I. Only)				37 PSI (255 kPa)		37 PSI (255 kPa)
Electrical System	12 V Negative (–) Ground					
Min. Battery Requirements	450 cca 575 mca 90A/h			650 cca, 825 mca, or 150A/h	550 cca, 700 mca or 120A/h	650 cca, 825 mca, or 150A/h
Firing Order	1-8-4-3-6-5-7-2					
Spark Plug Type	AC MR43T/Champion RV15YC4/NGK BR6FS					
Spark Plug Gap	.035 in (0.9 mm)					
Timing (at Idle RPM)	8 Degrees BTDC					
Preliminary Idle Mixture	1 1/4 Turns				1 1/4 Turns	
Thermostat	143° F (62° C)			160° F (71° C)	143° F (62° C)	160° F (71° C)

MIE (Inboard)

Model	MIE 7.4L	MIE 454 EFI	MIE 8.2L
Propshaft Ratings HP (KW)	310 (231)	395 (231)	400 (298)
Number of Cylinders	V-8		
Displacement	454 C.I.D (7.4L)		502 C.I.D. (8.2L)
Bore/Stroke	4.25x4.00 In. (108x101.6 mm)		4.47x4.00 (113.5x101.6)
Compression Ratio	8.0:1	8.6:1	
Compression Pressure	150 PSI (1034 kPa)		150 PSI (1034 kPa)
Idle RPM (in Forward Gear)	650	600	600
Max. RPM (at W.O.T.)	4000-4400	4600-5000	4400-4800
Oil Pressure (at 2000 RPM)	30-70 PSI (207-483 kPa)		
Min. Oil Pressure (at Idle)	4 PSI (28 kPa)		
Fuel Pump Pressure (at 1800 RPM)	3-7 PSI (21-48 kPa)		3-7 PSI (21-48 kPa)
Fuel Rail Pressure (Running) (E.F.I. Only)		37 PSI (255 kPa)	
Electrical System	12 V Negative (–) Ground		
Min. Battery Requirements	450 cca, 575 mca or 90A/h	650 cca, 825 mca, or 150A/h	550 cca, 700 mca or 120A/h
Firing Order	1-8-4-3-6-5-7-2		
Spark Plug Type	AC MR43T/Champion RV15YC4/NGK BR6FS		
Spark Plug Gap	.035 in (0.9 mm)		
Timing (at Idle RPM)	8 Degrees BTDC		
Preliminary Idle Mixture	1-1/4 Turns		1-1/4 Turns
Thermostat	143°F (62° C)	160° F (71° C)	143°F (62° C)

LH ROTATION
FRONT



Firing Order
1-8-4-3-6-5-7-2

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Fluid Capacities

NOTICE

All capacities are approximate fluid measures.

All capacities are U.S. Quarts (Litres).

MODEL	MCM AND MIE 454 CID / 7.4L	MCM AND MIE 7.4L MPI	MCM AND MIE 502 CID / 8.2L
Crankcase Oil[1] (With Filter)	7 (6.6)		7 (6.6)
Seawater Cooling System[2]	20 (19)		
Closed Cooling System	28 (26.5) [1] 18 (17) [2]	18 (17) [2]	28 (26.5) [2]

[1] Closed cooling system with manifolds included in coolant side of system.

[2] Closed cooling system without manifolds included in coolant side of system.

IMPORTANT: It may be necessary to adjust oil levels depending on installation angle and cooling systems (heat exchanger and fluid lines).

MAKE AND MODEL		CAPACITY QUARTS (LITRES)	FLUID TYPE
Hurth	630A	3-1/4 (3)	Dexron III Automatic Transmission Fluid
	630V	4.25 (4.0)	
	800A2	5-3/4 (5.5)	
	800AM	4-2/5 (4.2)	
Velvet Drive	1:1	2 (1.9)	

NOTE: *Always use dipstick to determine exact quantity of fluid required*

NOTE: *Seawater cooling system capacity information is for winterization use only*

All Models

20-Hour Break-In Period

IMPORTANT: The first 20 hours of operation is the engine break-in period. Correct break-in is essential to obtain minimum oil consumption and maximum engine performance. During this break-in period, the following rules must be observed:

- Do not operate below 1500 RPM for extended periods of time for first 10 hours. Shift into gear as soon as possible after starting and advance throttle above 1500 RPM **if conditions permit safe operation.**
- Do not operate at one speed consistently for extended periods.
- Do not exceed 3/4 throttle during first 10 hours. During next 10 hours, occasional operation at full throttle is permissible (5 minutes at a time maximum).
- Avoid full throttle acceleration from IDLE speed.
- Do not operate at full throttle until engine reaches normal operating temperature.

After Break-in Period

To help extend the life of your MerCruiser power package, the following recommendations should be considered;

- Use a propeller that allows the engine to operate at or near the top of the maximum RPM range (See “Specifications” section) when at full throttle with a normal boat load.
- Operation at 3/4 throttle setting or lower is recommended. Refrain from prolonged operation at maximum (full throttle) RPM.

End of First Season Checkup

At the end of the first season of operation, an Authorized MerCruiser Dealer should be contacted to discuss and/or perform various scheduled maintenance items. If you are in an area where the product is operated continuously (year-round operation), you should contact your dealer at the end of the first 100 hours of operation, or once yearly, whichever occurs first.

Fuel Specifications

Fuel

⚠CAUTION

Use of improper gasoline can damage the engine seriously. Engine damage that results from use of improper gasoline is considered misuse of the engine and is not covered under MerCruiser Warranty.

USA and Canada

Fuel having a posted pump Octane Rating of 87 (R + M) / 2 minimum. Premium gasoline [92 (R + M) / 2] is also acceptable . DO NOT use leaded gasolines.

Outside USA and Canada

Fuel having a posted pump Octane Rating of 92 RON minimum. Premium gasoline (98 RON) is also acceptable. If unleaded is not available, use a major brand of leaded gasoline.

Gasolines containing alcohol, either methyl alcohol (methanol) or ethyl alcohol (ethanol) may cause increased:

- Corrosion of metal parts.
- Deterioration of elastomer and plastic parts.
- Fuel permeation through flexible fuel lines.
- Wear and damage of internal engine parts.
- Starting and operating difficulties.

Some of these adverse effects are due to the tendency of gasolines containing alcohol to absorb moisture from the air, resulting in a phase of water and alcohol separating from the gasoline in the fuel tank.

The adverse effects of alcohol are more severe with methyl alcohol (methanol) and are worse with increasing alcohol content.

⚠WARNING

Fire and Explosion Hazard: Fuel leakage from any part of the fuel system can be a fire and explosion hazard which can cause serious bodily injury or death. Careful periodic inspection of the entire fuel system is mandatory, particularly after storage. All fuel system components including fuel tanks (whether plastic, metal or fiberglass), fuel lines, primer bulbs, fittings, fuel filters and carburetors should be inspected for leakage, softening, hardening, swelling or corrosion. Any sign of leakage or deterioration requires replacement before further engine operation.

Because of possible adverse effects of alcohol in gasoline, it is recommended that only alcohol-free gasoline be used where possible. If only fuel containing alcohol is available, or if the presence of alcohol is unknown, increased inspection frequency for leaks and abnormalities is required.

⚠WARNING

Avoid gasoline fire or explosion. Improper installation of brass fittings or plugs into fuel pump or fuel filter base can crack casting and/or cause a fuel leak.

IMPORTANT: When operating a MerCruiser engine on gasoline containing alcohol, storage of gasoline in the fuel tank for long periods should be avoided. Long periods of storage, common to boats, create unique problems. In cars, alcohol-blend fuels normally are consumed before they can absorb enough moisture to cause trouble, but boats often sit idle long enough for phase separation to take place. In addition, internal corrosion may take place during storage if alcohol has washed protective oil films from internal components.

GASOLINE / ALCOHOL BLENDS

Many new motor vehicle owner manuals are warning about the potential damage from using gasoline containing alcohol, especially METHANOL. They cite possible fuel system damage and performance problems. These are just two of the hazards that may be caused by alcohol. These same problems as well as the additional safety risk of fire and explosion from fuel system leaks apply to marine inboard engines. METHANOL is more severe in its bad effect than is ETHANOL. Alcohol is also more severe in older engines since newer engines have materials which are more resistant to alcohol.

EFFECTS OF GASOLINE / ALCOHOL BLENDS ON MARINE ENGINES

Corrosion of metals may result from use of alcohol-gasoline blends. Portable or permanently installed fuel tanks of metal or fiberglass, fuel filters, fuel lines and float bowls may be affected by alcohol blended fuels. Many fiberglass fuel tanks are slowly dissolved by alcohol, leading immediately to filter and carburetor plugging and eventually to tank failure.

Fuels containing alcohol will absorb mo from the air. At first, this moisture will remain tion,

but once the water content of the fuel has built up to about one-half of one percent, it will separate out (phase separation), bringing the alcohol with it. This alcohol-water mixture settles to the bottom of the fuel tank and if this mixture gets into the engine, the engine can be seriously damaged internally, as it may wash the protective film of oil off the bore of any cylinder that it enters. Before the engine can be restarted, it is necessary to remove the separated alcohol and water layer, flush out the fuel system with clean fuel and remove and dry the spark plugs.

BOAT / MOTOR STORAGE

When operating a MerCruiser engine on gasoline containing alcohol, storage of gasoline in the fuel tank for long periods of time should be avoided.

Long periods of storage, common to boats, create unique problems. In cars, gasoline/alcohol blend fuels normally are consumed before they can absorb enough moisture to cause trouble, but boats often sit idle long enough for phase separation to take place. In addition, internal corrosion may take place during storage if alcohol has washed protective oil films from internal components.

WINTER STORAGE

If boat is to be placed in winter storage, carburetors must be run dry at idle RPM. Permanent fuel tanks should be drained completely and Quicksilver Gasoline Stabilizer and Conditioner added to any fuel remaining in the tank. Portable fuel tanks should be emptied completely.

WARRANTY

Performance problems and fuel system or other damage resulting from the use of gasoline-alcohol blended fuels are not the responsibility of MerCruiser and will not be covered under our warranty.

CONTINUING EVALUATIONS

The effects of gasoline with ETHANOL and METHANOL are still being evaluated by the United States Coast Guard, the National Marine Manufacturers Association (NMMA), Mercury Marine and other engine and boat manufacturers.

We have recommended pump posting of alcohol content of gasoline. Further we recommend using gasoline known not to contain any METHANOL or ETHANOL when possible.

TEST FOR ALCOHOL CONTENT IN GASOLINE

The following is an acceptable and widely used field procedure for the detection of alcohol in gasoline. Use any small transparent bottle or tube that can be capped and is, or can be, provided with graduations or a mark at about 1/3 full. A pencil mark on a piece of adhesive tape may be used.

Procedure

1. Fill the container with water to the mark.
2. Add fuel almost to fill the container, leaving some air space, then cap the container. The proportions of fuel to water are not critical, but there should be 2 to 3 times as much fuel as water.
3. Shake container vigorously and allow it to sit **upright for 3 to 5 minutes**. If the volume of water appears to have increased, alcohol is present. If you are not sure, there is no need for concern. If the dividing line between water and fuel becomes cloudy, use the middle of the cloudy band.

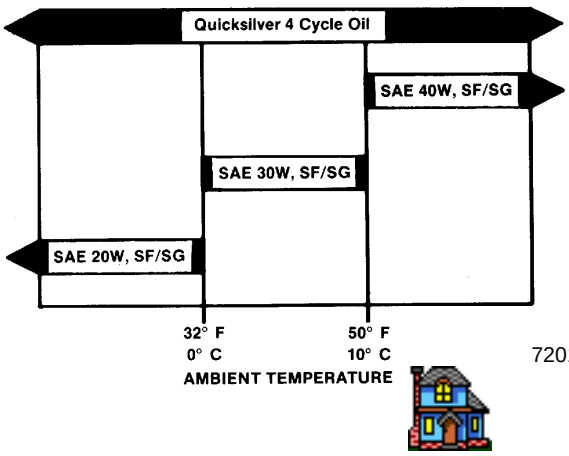
Crankcase Oil

To help obtain optimum engine performance and to provide maximum protection, we strongly recommend the use of Quicksilver 4-Cycle Marine Engine Oil. If not available, a good grade, straight weight, detergent automotive oil of correct viscosity, with an API classification of SF or SG, may be used.

The following chart is a guide to crankcase oil selection. Oil filter should always be changed with oil.

In those areas where recommended straight weight oil is not available, a multi-viscosity 20W-40 (SF or SG) or, as a second but less preferable choice, 20W-50 (SF or SG) may be used.

IMPORTANT: The use of non-detergent oils, multi-viscosity oils (other than 20W-40 or 20W-50), low quality oils or oils which contain solid additives specifically are not recommended.



Power Steering Fluid

Use Quicksilver Power Trim and Steering Fluid, or automatic transmission Fluid (ATF), Dexron, Dexron II, Dexron III.

Transmission Fluid

Velvet Drive - 10 wt. tractor hydraulic fluid meeting the C-3/TO-2 specification (preferably Mobil 424, Chevron, or Citgo).

Hurth - Automatic transmission fluid (ATF) Dexron II or Dexron III.

Coolant for Closed Cooling System

⚠CAUTION

Alcohol or Methanol base antifreeze or plain water, are not recommended for use in fresh water section of cooling system at any time.

We recommend that the coolant section of closed cooling system be filled with Quicksilver Pre-Mixed Engine Coolant. In areas where the possibility of freezing does not exist, it is permissible to use a solution of rust inhibitor and water (mixed to manufacturer's recommendations).

MerCruiser V-8 engines can use any type of permanent antifreeze or any brand antifreeze solution that meets GM specification 1825M.

Maintaining Crankcase Oil Level

Overfilled Engine Crankcase

Overfilled crankcases (oil level being too high) can cause a fluctuation or drop in oil pressure and rocker arm "clatter" on MerCruiser engines. The over-full condition results in the engine crankshaft splashing and agitating the oil, causing it to foam (become aerated). The aerated oil causes the hydraulic valve lifters to "bleed down." This, in turn, results in rocker arm "clatter" and loss of engine performance, due to the valves not opening properly.

Care must be taken when checking engine oil level. Oil level must be maintained between the ADD mark and the FULL mark on the dipstick. To ensure that you are not getting a "false reading," make sure the following steps are done before checking the oil level.

- Boat "at rest" in the water, or
- If boat is on a trailer, raise or lower bow until the boat is setting at the approximate angle that it would be if setting "at rest" in the water.
- Allow sufficient time for oil to drain into the crankcase if engine has just been run or oil has just been added.

Checking Engine Oil Level/Filling

IMPORTANT: ENGINE CRANKCASE OIL MUST BE CHECKED AT INTERVALS SPECIFIED IN "MAINTENANCE SCHEDULE" CHART. It is normal for an engine to use a certain amount of oil in the process of lubrication and cooling of the engine. The amount of oil consumption is greatly dependent upon engine speed, with consumption being highest at wide-open-throttle and decreasing substantially as engine speed is reduced.

1. Stop engine and allow boat to come to a rest.
2. Allow oil to drain back into oil pan - approximately 5 minutes.
3. Remove dipstick. Wipe clean and reinstall. Push dipstick all the way into dipstick tube.
4. Remove dipstick and note the oil level.
5. Oil level must be between the FULL and ADD marks.
6. If oil level is below ADD mark, proceed to Steps 7 and 8.
7. Remove oil filler cap from valve rocker arm cover.
8. Add required amount of oil to bring level up to, but not over, the FULL mark on dipstick.

Changing Oil and Filter

1. Start engine and run until it reaches normal operating temperatures.

IMPORTANT: Change oil when engine is warm from operation, as it flows more freely, carrying away more impurities.

2. Stop engine.
3. Remove drain plug from oil pan or from oil drain hose.

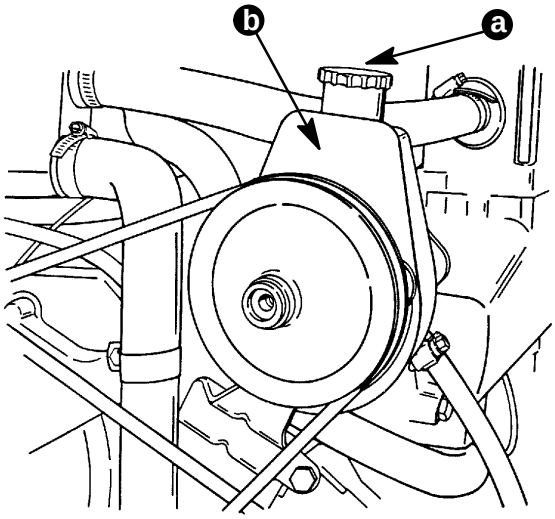
NOTE: *If drain plug is not accessible because of boat construction, oil may be removed through dipstick tube, using a Quicksilver Crankcase Oil Pump. (See Quicksilver Accessory Guide.)*

4. After oil has drained completely, reinstall drain plug (if removed) and tighten securely.
5. Remove and discard oil filter and its sealing ring.
6. Coat sealing ring on new filter with engine oil, and install. Tighten filter securely (following filter manufacturer's instructions). Do not over-tighten.
7. Fill crankcase with oil.
8. Start engine and check for leaks.

Maintaining Power Steering Pump Fluid Level

With Engine Warm

1. Stop engine and position drive unit so that it is straight back.
2. Remove fill cap/dipstick from power steering pump and note fluid level.



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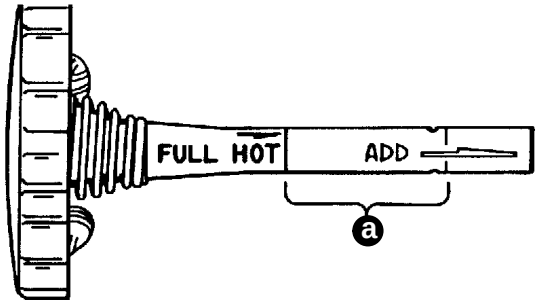
a - Fill Cap / Dipstick
b - Power Steering Pump

3. Level should be between the FULL HOT mark and ADD mark on dipstick.



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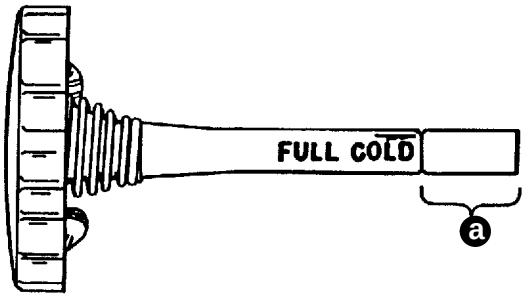
a - Proper Fluid Level with Engine Warm

4. If level is below ADD mark, but fluid is still visible in pump reservoir, add required amount of Quicksilver Power Trim and Steering Fluid or automatic transmission fluid (ATF), Dexron, or Dexron II, through fill cap opening, to bring level up to FULL HOT mark on dipstick. DO NOT OVERFILL.
5. If fluid is not visible in reservoir, a leak exists in the power steering system. Find cause and correct.

With Engine Cold

1. With engine stopped, position drive unit so that it is straight back.
2. Remove fill cap/dipstick from power steering pump and note fluid level.
3. Level should be between FULL COLD mark and bottom of dipstick.



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a - Proper Fluid Level with Engine Cold

4. If level is below bottom of dipstick, but fluid is still visible in pump reservoir, add required amount of Quicksilver Power Trim and Steering Fluid or automatic transmission fluid (ATF), Dexron Dexron II, or Dexron III, through fill cap opening, to bring level up to FULL COLD mark on dipstick. DO NOT OVERFILL.

If fluid is not visible in reservoir, a leak exists in the power steering system. Find cause and correct.

Filling and Bleeding Power Steering System

IMPORTANT: Power steering system must be filled exactly as explained in the following to be sure that all air is bled from the system. All air must be removed, or fluid in pump may foam during operation and be discharged from pump reservoir. Foamy fluid also may cause power steering system to become spongy, which may result in poor boat control.

1. With engine stopped, position drive unit so that it is straight back. Remove fill cap/dipstick from power steering pump. Add Quicksilver Power Trim and Steering Fluid or automatic transmission fluid (ATF), Dexron, Dexron II or Dexron III, as required, to bring level up to FULL COLD mark on dipstick.

IMPORTANT: Use only Quicksilver Power Trim and Steering Fluid or automatic transmission fluid (ATF), Dexron, Dexron II or Dexron III in power steering system.

2. Turn steering wheel back and forth to end of travel in each direction several times, then recheck fluid level and add fluid, if necessary.
3. Install vented fill cap.

⚠CAUTION

DO NOT operate engine without water being supplied to seawater pickup pump, or pump impeller may be damaged and subsequent overheating damage to engine may result.

4. Start engine and run at fast idle (1000-1500 RPM) until engine reaches normal operating temperature. During this time, turn steering wheel back and forth to end of travel in each direction several times.
5. Position drive unit so that it is straight back and stop engine. Remove fill cap from pump. Allow any foam in pump reservoir to disperse, then check fluid level and add fluid, as required, to bring level up to FULL HOT mark on dipstick. DO NOT OVERFILL**.** Reinstall fill cap securely.

IMPORTANT: Drive unit must be positioned straight back and power steering fluid must be hot to accurately check fluid level.

6. If fluid is still foamy (in Step 5), repeat Steps 4 and 5 until fluid does not foam and level remains constant.

Maintaining Closed Cooling Coolant Level

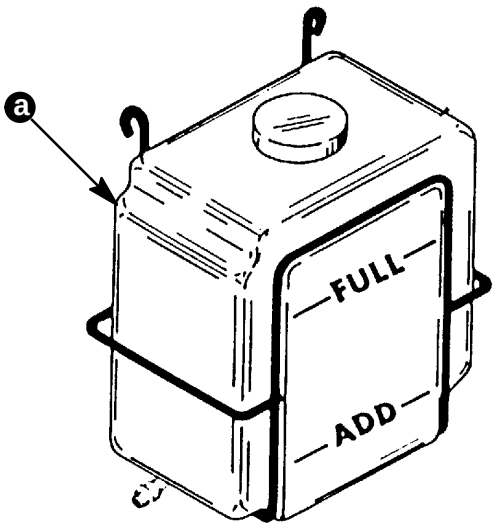
⚠WARNING

Allow engine to cool down before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled, turn cap 1/4 turn to allow any pressure to escape slowly, then push down and turn cap all the way off.

1. Coolant level in heat exchanger should be full (to bottom of filler neck).

IMPORTANT: When reinstalling pressure cap, be sure to tighten it until it contacts stop on filler neck.

2. Coolant level should be between the ADD and FULL marks on coolant recovery reservoir with the engine at normal operating temperature.



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a - Coolant Recovery Reservoir

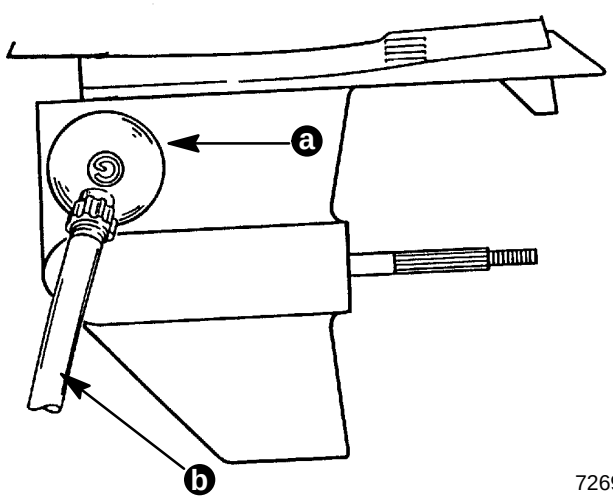
Flushing Cooling System

If engine is operated in salty, polluted, or mineral-laden water, flush cooling system (preferably after each use) to reduce corrosion and prevent the accumulation of deposits in the system. Thoroughly flush cooling system prior to storage.

MCM (Stern Drive)

BOAT OUT OF WATER

1. Install flushing attachment over water pickup holes in gear housing as shown.
2. Attach a garden hose between the flushing attachment and a water tap.



72693

a - Flushing Attachment
b - Hose

⚠WARNING

When flushing, be certain the area around propeller is clear, and no one is standing nearby. To avoid possible injury, remove propeller.

⚠CAUTION

Do not run engine above 1500 RPM when flushing. Suction created by seawater pickup pump may collapse flushing hose, causing engine to overheat.

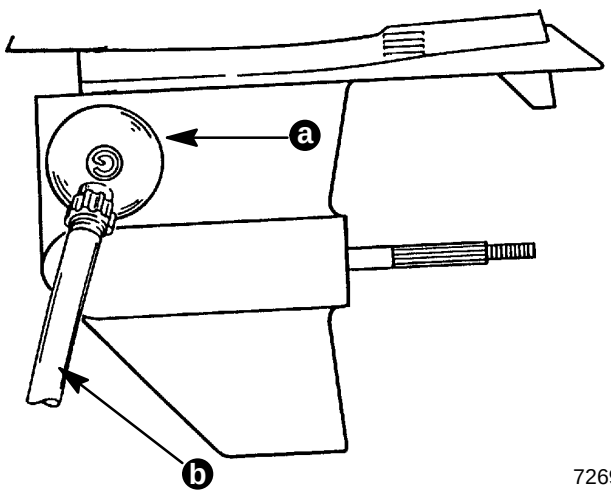
⚠CAUTION

Watch temperature gauge on dash to ensure that engine does not overheat.

3. Partially open water tap (approximately 1/2 maximum capacity). DO NOT use full water pressure.
4. Place remote control in neutral, idle speed position, and start engine.
5. Operate engine at idle speed in neutral for 10 minutes, or until discharge water is clear, then stop engine.
6. Shut off water tap. Remove garden hose and flushing attachment.

BOAT IN WATER

1. Raise drive unit to full UP position.
2. Install flushing attachment over water pickup holes in gear housing as shown.
3. Attach a garden hose between the flushing attachment and a water tap.



72693

a - Flushing Attachment
b - Hose

4. Lower drive unit to full IN position.

⚠CAUTION

Do not run engine above 1500 RPM when flushing. Suction created by seawater pickup pump may collapse flushing hose, causing engine to overheat.

⚠CAUTION

Watch temperature gauge on dash to ensure that engine does not overheat.

5. Partially open water tap (approximately 1/2 maximum capacity). DO NOT use full water pressure.
6. Place remote control in neutral, idle speed position, and start engine.
7. Operate engine at idle speed in neutral for 10 minutes, then stop engine.
8. Shut off water tap.
9. Raise drive unit to full UP position.
10. Remove garden hose and flushing attachment.

⚠CAUTION

If boat is in the water, seacock, if so equipped, must remain closed until engine is to be re-started, to prevent water from flowing back into cooling system and/or boat. If boat is not fitted with a seacock, water inlet hose must be left disconnected and plugged (to prevent water from flowing back into cooling system and/or boat). As a precautionary measure, attach a tag to the ignition switch or steering wheel of the boat with the warning: Open seacock or reconnect water inlet hose before starting engine.

IMPORTANT: If a seacock is to be installed for this purpose, valve used must have an internal cross-sectional area equal to or greater than water inlet hose to prevent restricting water flow during normal operation. A 1-1/4 in. (32 mm), or larger, brass ball valve or gate valve is recommended.

1. If boat is in water, close seacock, if so equipped, or disconnect and plug seawater inlet hose to prevent seawater from entering boat.
2. Remove inlet hose from seawater pickup pump.
3. Using an adaptor, connect a garden hose from a water tap to seawater pump inlet.
4. Partially open water tap (approximately 1/3 maximum). Do not use full water pressure.
5. Place the remote control lever in neutral position and start engine.

⚠WARNING

When flushing, be certain the area around propeller is clear, and no one is standing nearby. To avoid possible injury, remove propeller.

⚠CAUTION

Do not run engine above 1500 RPM when flushing. Suction created by seawater pickup pump may collapse flushing hose, causing engine to overheat.

⚠CAUTION

Watch temperature gauge on dash to ensure that engine does not overheat.

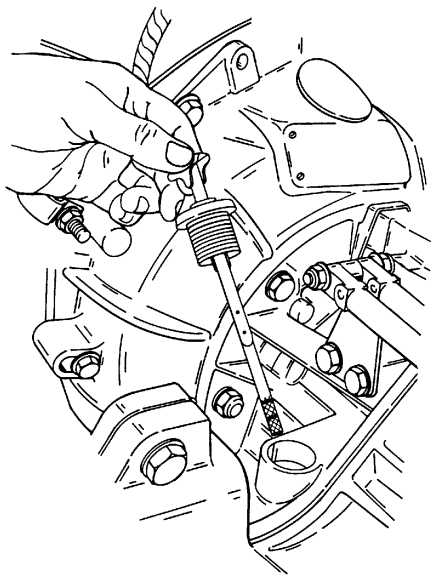
6. Operate engine at idle speed in neutral for 10 minutes, or until discharge water is clear. Stop engine.
7. Shut off water tap. Remove garden hose and adaptor from pump inlet and reconnect water inlet hose. Be sure to tighten hose clamp securely.

IMPORTANT: If boat is in the water, do not open water inlet valve until engine is to be restarted to prevent contaminated water from flowing back into engine. If boat is not fitted with a valve, leave water inlet hose disconnected and plugged.

Maintaining Transmission Fluid Level

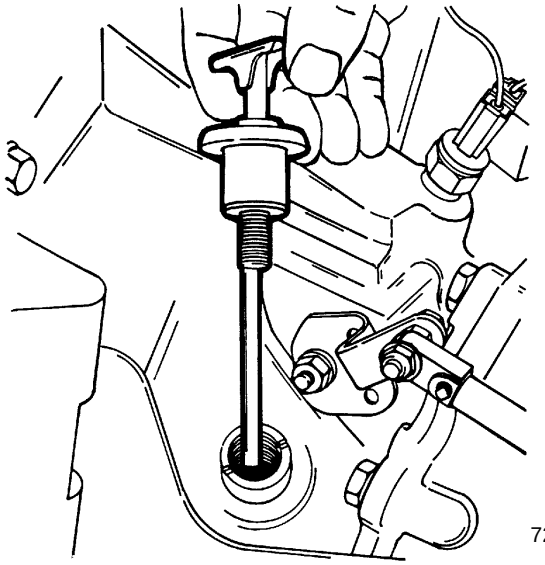
IMPORTANT: Be sure to push dipstick all the way down into dipstick tube when checking fluid level.

1. Remove dipstick to check transmission fluid level. Fluid level may be over the full mark because fluid from the cooler and lines has drained back into the transmission. If fluid level is low, add the specified fluid through the dipstick hole until full mark on dipstick is reached. DO NOT OVERFILL.



72527

Hurth



72526

Velvet Drive

IMPORTANT: To accurately check fluid level, engine MUST BE run at 1500 RPM for 2 minutes immediately prior to checking level.

2. Start engine and run at 1500 RPM for 2 minutes to fill all circuits, lines, and cooler.
3. Stop engine and quickly check level before fluid drains back into transmission. Add fluid if necessary.
4. If fluid level is extremely low, check transmission case, cooler, and hoses for leaks.

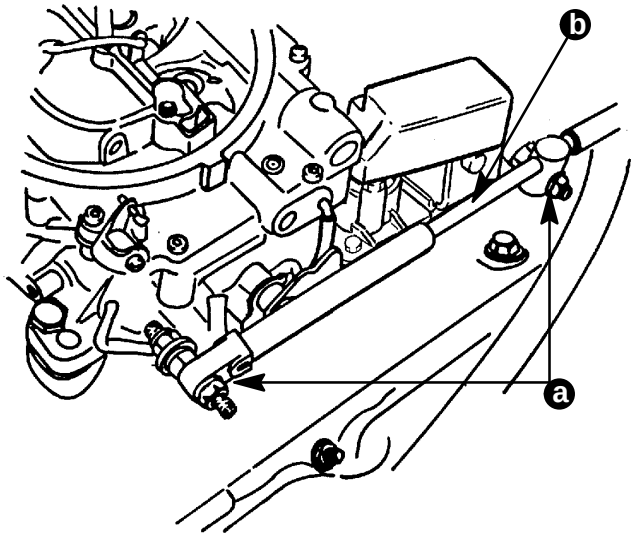
IMPORTANT: Velvet Drive - transmission - use 10 wt. tractor hydraulic fluid meeting the C-3/TO-2 specification (preferably Mobil 423, Chevron, or Citgo).

Hurth transmission - use Dexron II or Dexron III automatic transmission fluid (ATF).

Lubrication

Throttle Cable

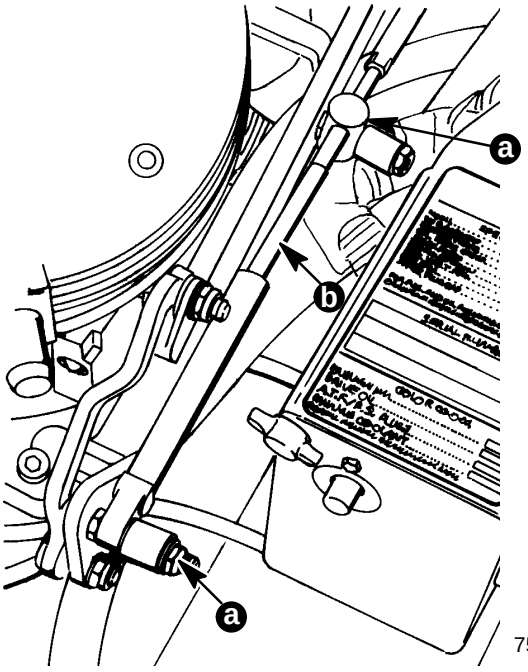
MODELS WITH 4 BARREL CARBURETOR



72014

a - Pivot Points
b - Guide Contact Surface

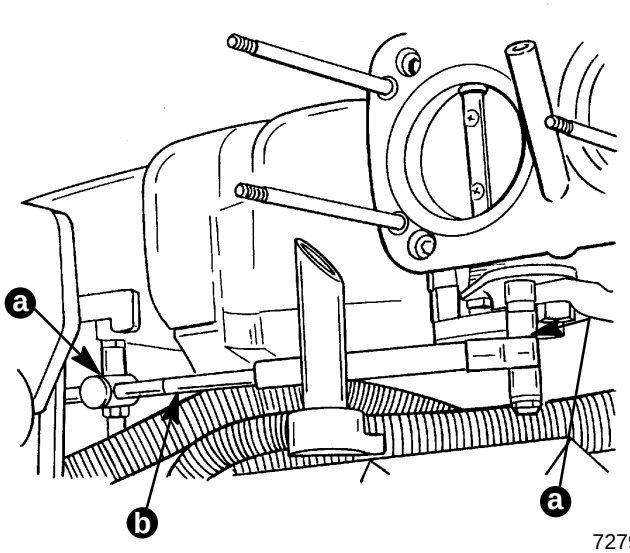
MODELS WITH THROTTLE BODY FUEL INJECTION



75038

a - Pivot Points
b - Guide Contact Surface

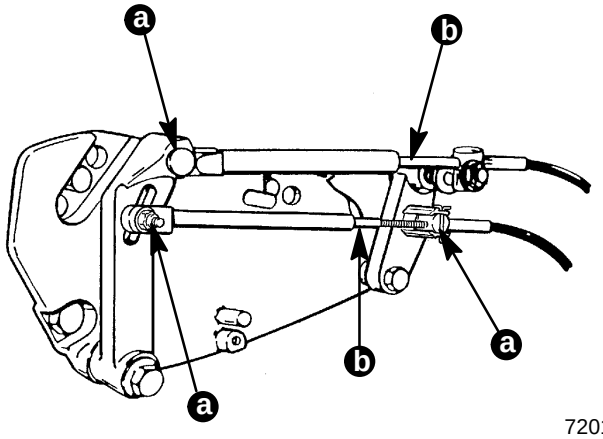
MODELS WITH MULTI-PORT FUEL INJECTION



72791

a - Pivot Points
b - Guide Contact Surface

Shift Cable

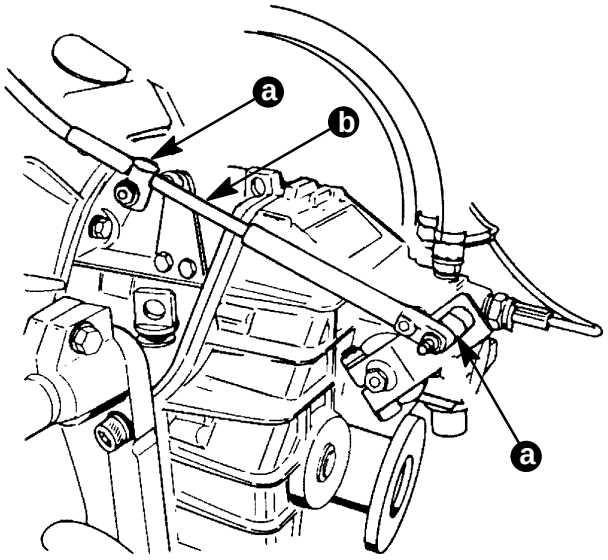


72016

MCM Models - Typical Shift Cable

a - Pivot Points
b - Guide Contact Surface

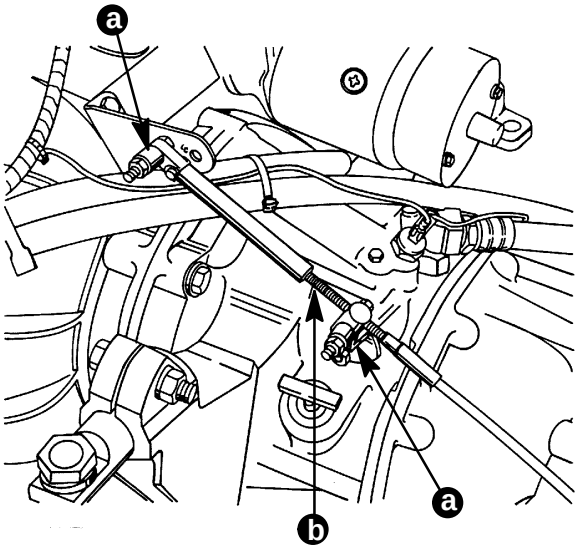
MIE MODEL TYPICAL SHIFT CABLE AND TRANSMISSION LINKAGE



71208

Hurth

a - Pivot Points
b - Guide Contact Surface



72528

Velvet Drive

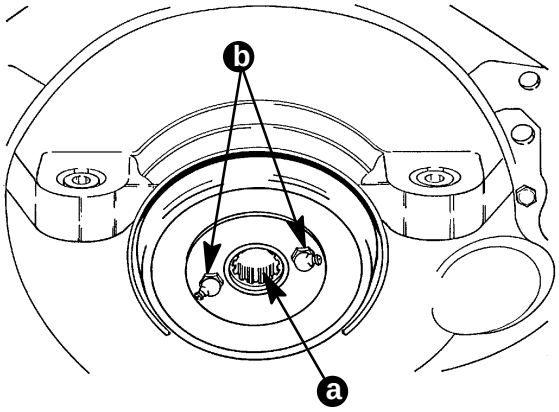
a - Pivot Points
b - Guide Contact Surface

Engine Coupler/U-Joint Shaft Splines

NOTE: *Engine coupler and shaft splines are greased with Quicksilver Engine Coupler Spline Grease, 92-816391A4; universal joints are greased with Quicksilver 2-4-C Marine Lubricant.*

NOTE: *Refer to MerCruiser Stern Drive Service Manual for stern drive unit removal and installation, if necessary.*

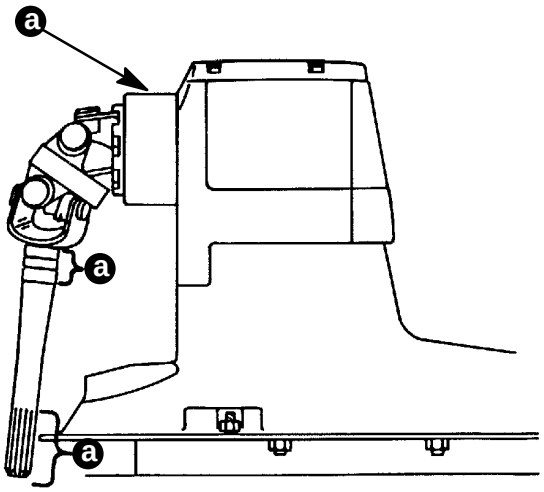
IMPORTANT: Stern Drive Unit does not have to be removed to grease coupler.



72529

MCM Models

a - Quicksilver Engine Coupler Spline Grease
b - Grease Fitting(s) Use Grease Fitting If Drive Is Installed

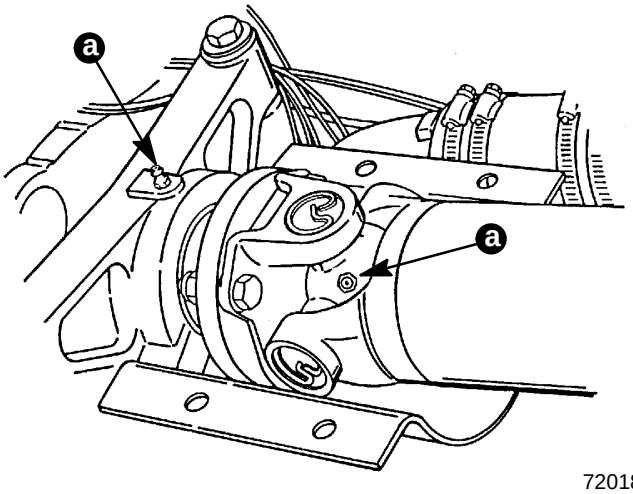


72531

Typical Bravo Drive

a - Quicksilver Engine Coupler Spline Grease

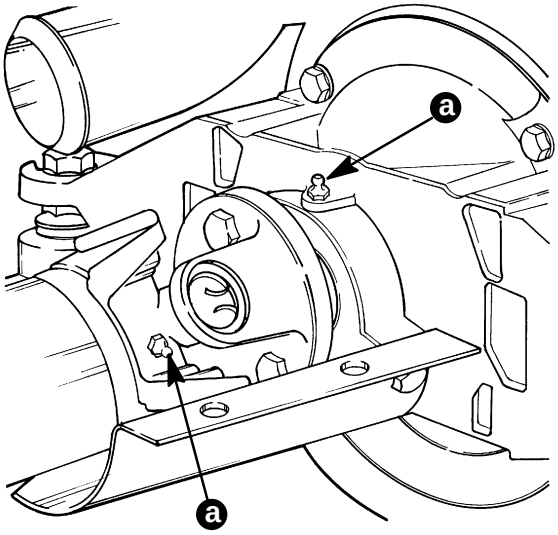
Drive Shaft Extension Models



72018

Transom End

a - Lubrication Points



72028

Engine End

a - Lubrication Points

Starter Motor

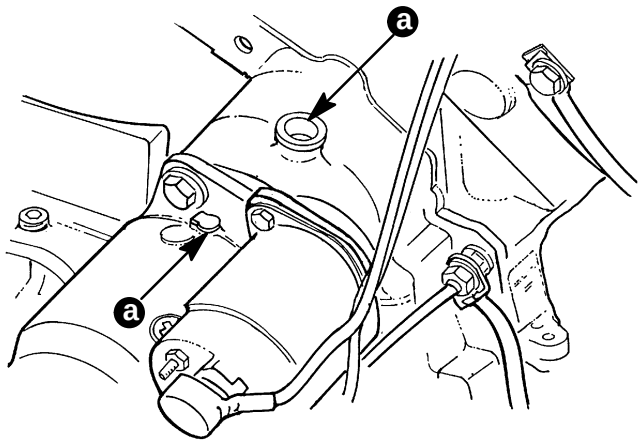
MIE MODELS

⚠ WARNING

When performing the following procedure, be sure to observe the following:

- **Be sure that engine compartment is well ventilated and that no gasoline vapors are present to avoid the possibility of a fire.**
- **Be sure to ground coil high-tension wire to block. Failure to ground coil wire may cause damage to ignition coil in addition to being a safety hazard.**
- **Stay clear of all moving parts.**

1. Remove ignition coil high-tension wire from distributor cap tower and ground it to engine block with jumper wire. While cranking engine with starter motor, lubricate starter motor front bushing through oil cover with motor oil or its equivalent. Reinstall coil high-tension wire.
2. Remove plastic plug from flywheel housing. Lubricate starter motor shaft with motor oil through hole in flywheel housing. Reinstall plastic plug.



72019

a - Lubrication Points

Cold Weather or Extended Storage

Precautions

⚠ WARNING

BE CAREFUL while working on fuel system; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF and do not smoke or allow sources of spark and/or open flames in the area.

⚠ WARNING

To prevent a potential fire hazard, be sure that engine compartment is well ventilated and that there are no gasoline vapors present during starting or fogging of engine.

⚠ CAUTION

DO NOT operate engine without cooling water being supplied to seawater pickup pump or water pump impeller will be damaged and subsequent overheating damage to engine may result.

⚠ CAUTION

Seawater (Raw-water) section of cooling system MUST BE COMPLETELY drained for winter storage, or immediately after cold weather use, if the possibility of freezing temperatures exists. Failure to comply may result in trapped water causing freeze and/or corrosion damage to engine.

⚠ CAUTION

If boat is in the water, seacock (water inlet valve), if so equipped, must be left closed until engine is to be re-started, to prevent water from flowing back into cooling system and/or boat. If boat is not fitted with a seacock, water inlet hose must be left disconnected and plugged (to prevent water from flowing back into cooling system and/or boat). As a precautionary measure, attach a tag to the ignition switch or steering wheel of the boat with the warning: Open seacock or reconnect water inlet hose before starting engine.

IMPORTANT: Observe the following information to ensure complete draining of cooling system.

- **Engine must be as level as possible.**
- **A wire should be repeatedly inserted into all drain holes to ensure there are no obstructions in passages. Remove petcock, if necessary, to insert wire completely into drain hole.**

IMPORTANT: To prevent threads in manifolds, elbows and cylinder blocks from rusting out during storage, reinstall plugs using Quicksilver Perfect Seal on threads. Never leave drain plugs out during storage.

⚠CAUTION

Stern drive unit should be stored in full "down" position. Universal Joint bellows may develop a "set" if unit is stored in raised position and may fail when unit is returned to service.

NOTE: *If possible, place a container under drains and hoses to prevent water from draining into boat.*

⚠CAUTION

If engine is equipped with Closed Cooling System, Closed Cooling section must be kept filled with a solution of ethylene glycol antifreeze and water (mix antifreeze to manufacturer's recommended proportions to protect engine to lowest temperature to which it will be exposed). DO NOT USE PROPYLENE GLYCOL antifreeze in closed cooling section. Seawater section, however, must be drained completely.

⚠CAUTION

A discharged battery can be damaged by freezing.

Layup

NOTICE

Refer to "Cold Weather or Extended Storage," "Precautions," in this section, BEFORE proceeding.

1. Fill fuel tank(s) with fresh gasoline that does not contain alcohol and a sufficient amount of Quicksilver Gasoline Stabilizer and Conditioner to treat the gasoline.

IMPORTANT: If boat is to be placed in storage (with fuel containing alcohol in fuel tanks), carburetors or vapor separator tanks must be run dry at idle RPM. Fuel tanks should be drained completely and Quicksilver Gasoline Stabilizer and Conditioner added to any fuel remaining in the tank. Also, refer to "Fuel Specifications," see Table of Contents.

2. Replace all fuel filters
3. Start engine and check for fuel leaks.
4. Run engine sufficiently to heat it to normal operating temperature; shut off engine and change oil and filter.
5. If boat has been operated in salty, polluted or mineral-laden waters, flush cooling system.
6. Prepare fuel system for extended storage as follows:

   a. **For engines with carburetors:**

      Remove flame arrestor assembly and restart engine. While operating engine at fast idle (1000-1500 RPM), fog internal surfaces of induction system and combustion chambers by squirting approximately 8 ounces (227 grams) of Quicksilver Storage Seal or SAE 20W engine oil into carburetor bores. Stall engine by squirting last 2 ounces (57 grams) of Storage Seal or oil rapidly into carburetor. Turn ignition to OFF.

   b. **For fuel injected engines with VST:**

⚠WARNING

Fuel injection system is pressurized. A special procedure must be used to remove this pressure before removing the plug from vapor separator tank. DO NOT attempt to remove plug without having pressure removed. Fuel could spray on hot engine causing fire or explosion.

(1) Relieve fuel pressure from system. Refer to “Fuel Pressure Relief Procedure” in Section 5C.

(2) Remove plug from top of vapor separator tank.

(3) Add approximately 1 fluid ounce (30 ml) of Quicksilver 2-Cycle Outboard Oil to fuel in the vapor separator tank.

(4) Shut off the fuel supply to the engine’s fuel pump.

(5) Start engine and run at idle speed until the vapor separator tank and fuel injection system is empty.

(6) Reinstall the plug in top of vapor separator tank.

c. **For fuel injected engines with Cool Fuel system:**

(1) Fill fuel tank(s) with fresh gasoline (that does not contain alcohol) and a sufficient amount of Quicksilver Gasoline Stabilizer for Marine Engines to treat gasoline. Follow instructions on container.

(2) **If boat is to be placed in storage with fuel containing alcohol in fuel tanks (if fuel without alcohol is not available):** Fuel tanks should be drained completely and Quicksilver Gasoline Stabilizer for Marine Engines added to any fuel remaining in the tank. Refer to “FUEL REQUIREMENTS” for additional information.

(3) Prepare fuel system for extended storage as follows:

(4) Allow engine to cool down.

(5) Remove the water separating fuel filter.

(6) Pour out a small amount of fuel into a suitable container, then add approximately 2 fluid ounces (60 ml) of Quicksilver 2-Cycle Outboard Oil to fuel in the water separating fuel filter.

(7) Install water separating fuel filter.

(8) Shut off the fuel supply to the engine.

(9) Start and run engine at idle speed for two minutes.

(10) Stop engine, remove and discard new water separating fuel filter and in line fuel filter.

(11) Install new filters.

(12) Close fuel shut-off valve, if so equipped.

7. Close fuel shutoff valve, if so equipped.
8. Clean flame arrestor and crankcase ventilation hoses and reinstall.
9. Lubricate all items outlined in “Lubrication.”
10. Drain seawater section of cooling system, as outlined in “Draining Instructions” following.
11. **Closed Cooling System Models:** Test coolant to ensure that it will withstand lowest temperature expected during storage.
12. Service batteries.
13. Clean outside of engine and repaint any areas required with Quicksilver Primer and Spray Paint. After paint has dried, spray Quicksilver Corrosion and Rust Preventive Type II or wipe down with Quicksilver Storage Seal or SAE 20W engine oil.
14. For drive unit, refer to appropriate stern drive manual.

Draining Instructions

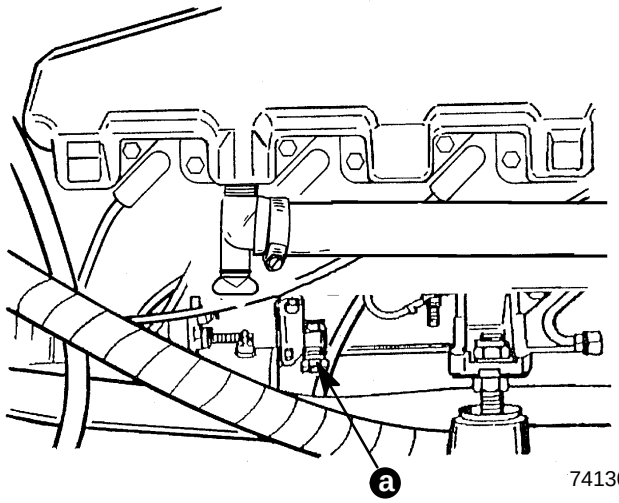
DRAINING SEAWATER (RAW-WATER) COOLED MODELS

NOTICE

Refer to "Cold Weather or Extended Storage," "Precautions," in this section, BEFORE proceeding.

MCM (Stern Drive) Models:

1. Engine must be as level as possible to ensure complete draining of cooling system.
2. Remove drain plugs (port and starboard) from cylinder block.



Starboard Side Shown (Port Similar)

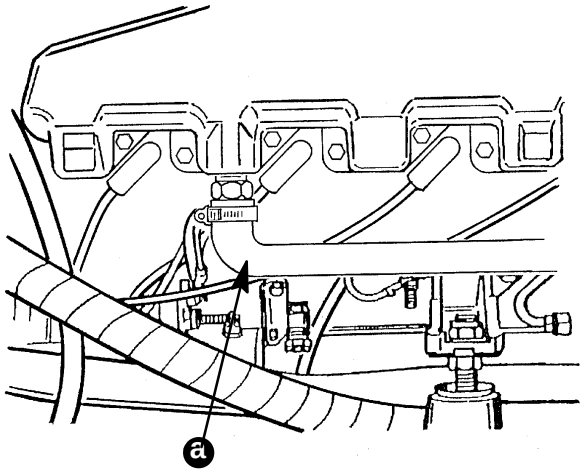
a - Drain Plug

3. Repeatedly clean out drain holes using a stiff piece of wire. Do this until entire system is drained.

NOTE: *It may be necessary to lift, bend, or lower hoses to allow water to drain completely when hoses are disconnected.*

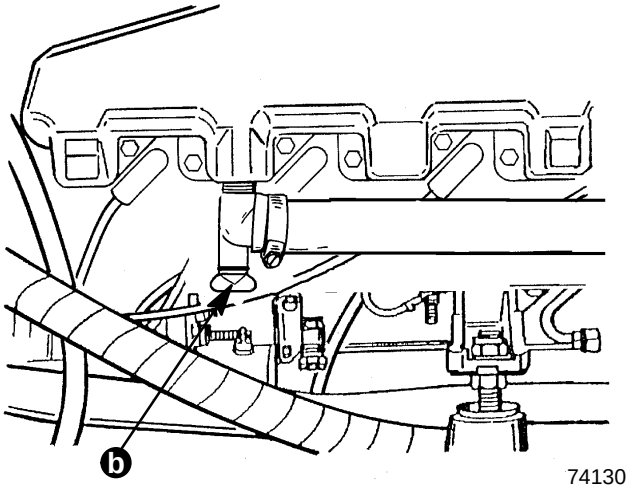
4. Remove hose or drain plug from bottom of port and starboard exhaust manifolds.

NOTE: *With the engine level, sufficient draining of manifolds will occur when the hose or drain plug is removed from the elbow in the exhaust manifold.*



Engine with Drain Plug In Exhaust Manifold

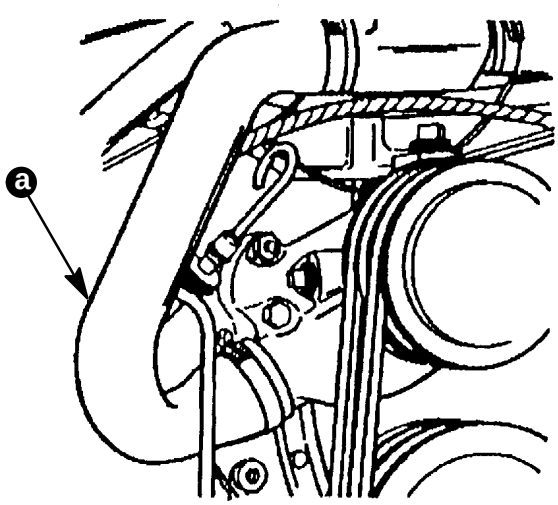
a - Bottom Hose, Exhaust Manifold To Thermostat Housing



Starboard Side Shown (Port Similar)

a - Drain Plug

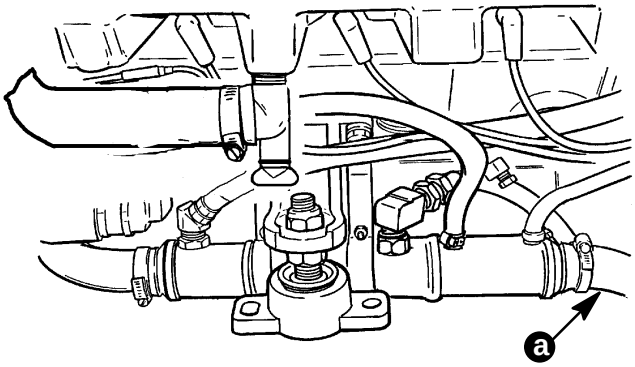
5. Remove the engine water circulating pump hose as shown.



72587

a - Hose, Water Circulating Pump To Thermostat Housing

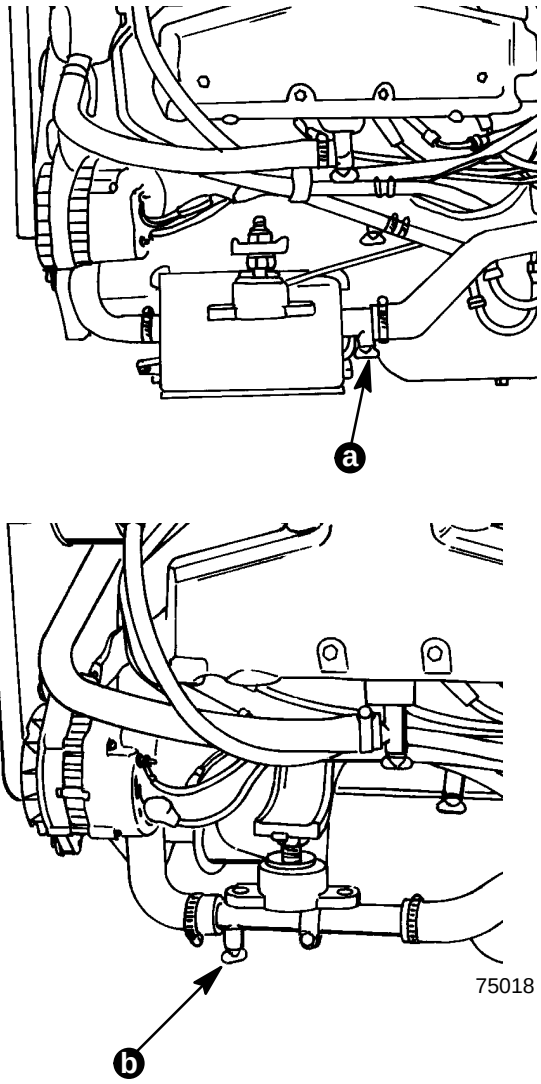
6. **On 7.4L and 454 Magnum Engines:** Remove the oil/power steering fluid cooler seawater hose, as shown.



72925

a - Hose, Seawater Pump To Cooler

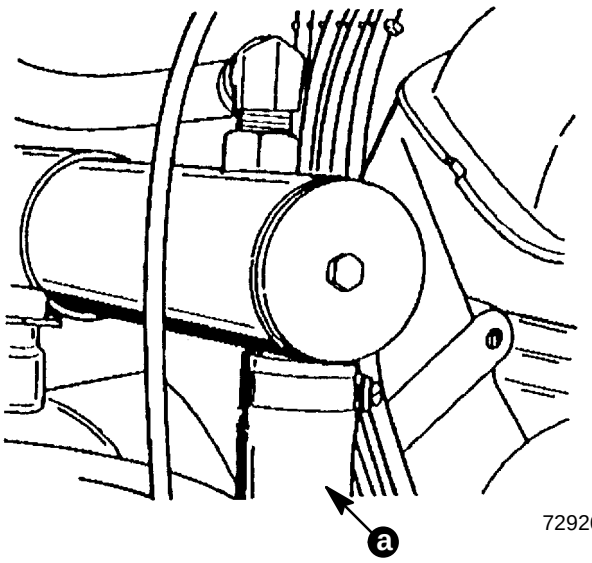
7. **On Cool Fuel Models or Carbureted models wit port side water tube:** Remove the drain screw from the fuel cooler**.**



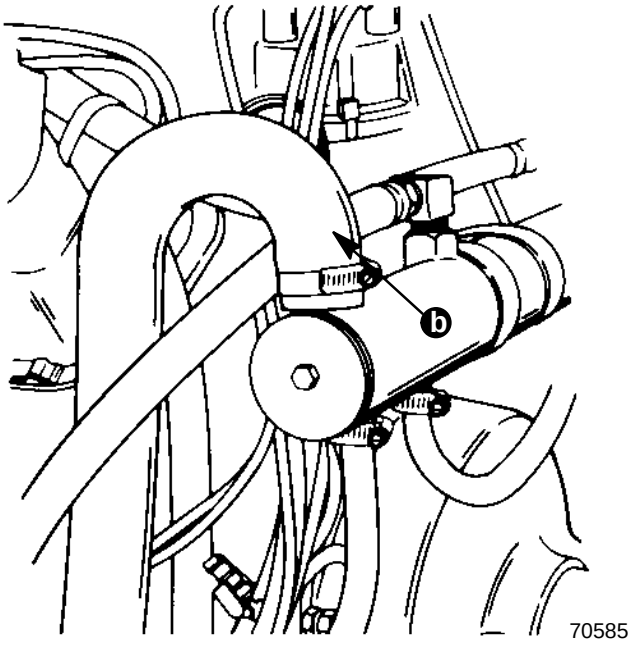
75018

a - Cool Fuel Model
b - Carbureted Model

8. **On 502 Engines:** Remove the oil/power steering fluid cooler seawater hoses, as shown.

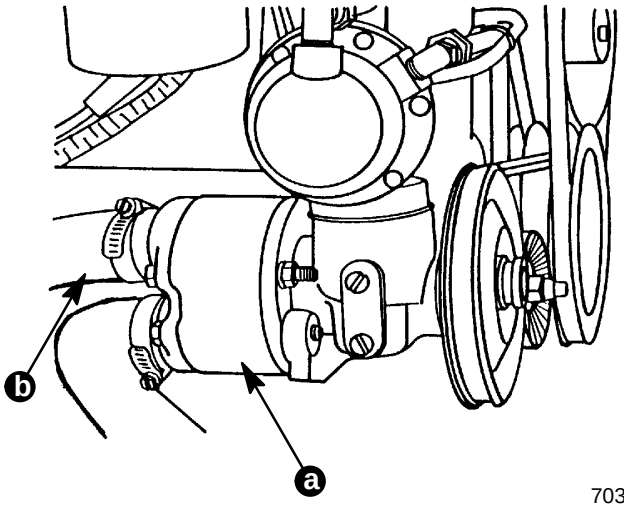


a - Hose, Seawater Pump To Cooler



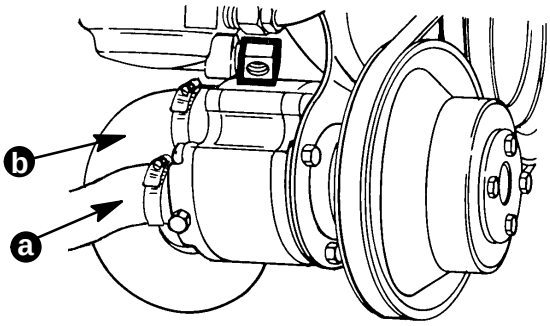
a - Hose, Oil / Power Steering Cooler To Heat Exchanger

a. Remove seawater pump inlet hose as shown.



Engines With Combination Seawater / Mechanical Fuel Pump

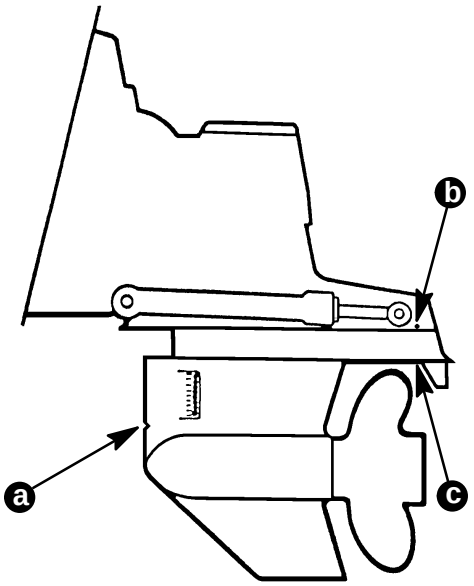
a - Seawater Pickup Pump
b - Inlet Hose



Engines WIth Cool Fuel System

a - Seawater Inlet Hose
b - Hose To Cooler

9. Insert a small wire (repeatedly) to make sure that speedometer pitot tube, trim tab cavity vent hole, and trim tab cavity drain passage are unobstructed and drained.



71217

Typical Bravo Drive Unit

a - Speedometer Pitot Tube
b - Trim Tab Cavity Vent Hole
c - Trim Tab Cavity Drain Passage

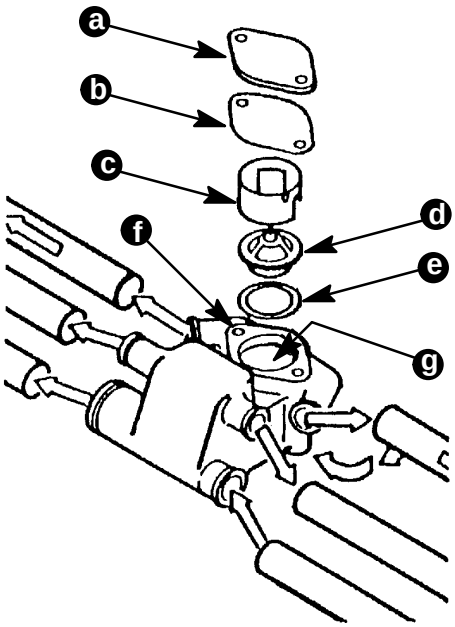
   a. Crank engine over slightly with starter motor to purge any water trapped in seawater pickup pump. DO NOT ALLOW ENGINE TO START.

   b. After cooling system has been drained completely, coat threads of drain plugs with Quicksilver Perfect Seal. Install all drain plugs and tighten securely. Reconnect all hoses and tighten all hose clamps securely.

IMPORTANT: MerCruiser recommends that propylene glycol antifreeze (nontoxic and biodegradable, which makes it friendly to lakes and rivers) be used in sea-water section of the cooling system for cold weather or extended storage. Make sure that the propylene glycol antifreeze contains a rust inhibitor and is recommended for use in marine engines. Be certain to follow the propylene glycol manufacturer's recommendations.

10. For additional assurance against freezing and rust, remove the thermostat cover and thermostat. Fill the engine seawater cooling system with a mixture of antifreeze and tap water mixed to manufacturer's recommendation to protect engine to the lowest temperature to which it will be exposed during cold weather or extended storage. Using a new gasket, reinstall thermostat and cover. Tighten cover bolts to 30 lb. ft. (41 N·m).

NOTE: *Hoses shown removed only to indicate flow. Do not remove hoses.*



72589

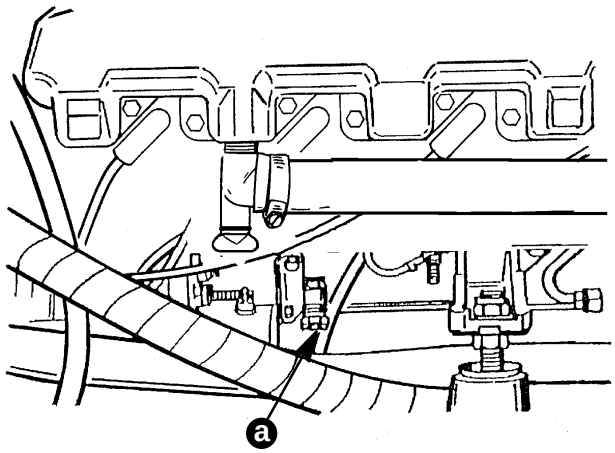
a - Cover
b - Gasket
c - Spacer
d - Thermostat
e - O-Ring
f - Housing
g - Fill Here

MIE (Inboard) Models:

NOTICE

Refer to "Cold Weather or Extended Storage," "Precautions," in this section, BEFORE proceeding.

1. Engine must be as level as possible to ensure complete draining of cooling system.
2. Remove drain plugs (port and starboard) from cylinder block.



74130

Starboard Side Shown (Port Similar)

a - Drain Plug

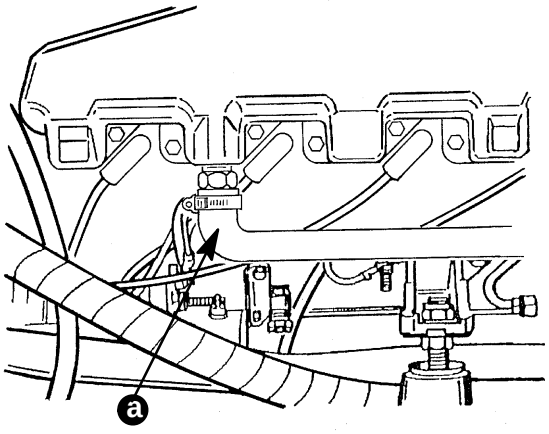
3. Repeatedly clean out drain holes using a stiff piece of wire. Do this until entire system is drained.

NOTE: *It may be necessary to lift, bend, or lower hoses to allow water to drain completely when hoses are disconnected.*

4. Remove hose or drain cock from bottom of port and starboard exhaust manifolds.

NOTE: *With the engine level, sufficient draining of manifolds will occur when exhaust manifold-to-thermostat housing hoses or drain cocks are removed.*

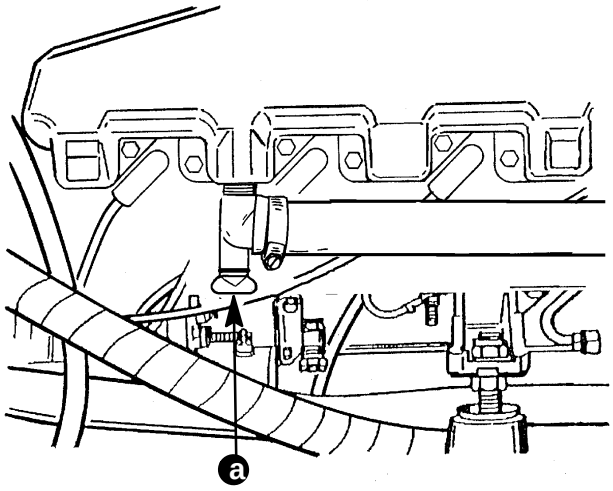
NOTE: *Some engines may be equipped with drain plugs in the elbows on exhaust manifolds. Remove drain plugs only.*



72609

Engine With Drain Plugs In Exhaust Manifolds

a - Bottom Hose, Exhaust Manifold To Thermostat Housing

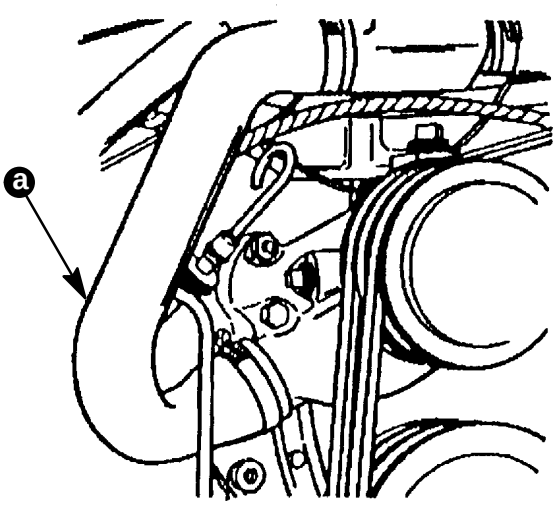


74130

Starboard Shown (Port Similar)

a - Drain Plug

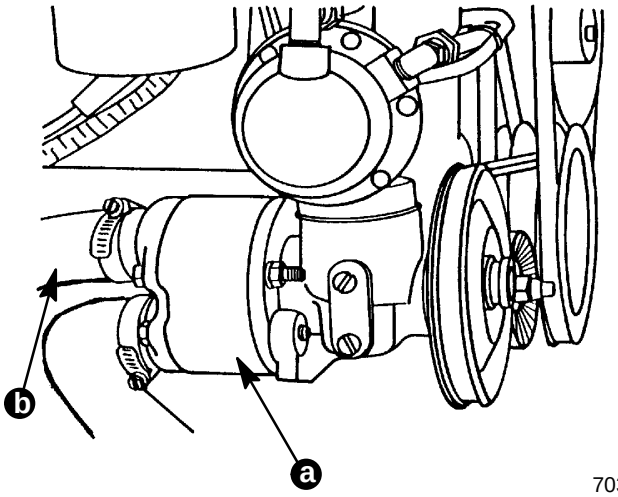
5. Remove the engine water circulating pump hose as shown.



72587

a - Hose, Water Circulating Pump To Thermostat Housing

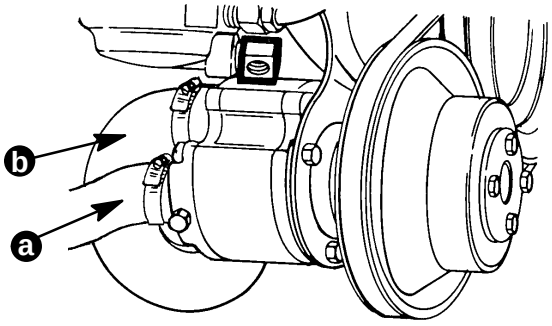
6. Remove hose from the seawater pump, as shown.



70346

Engines With Combination Seawater / Mechanical Fuel Pump

a - Seawater Pickup Pump
b - Hose, Seawater Inlet

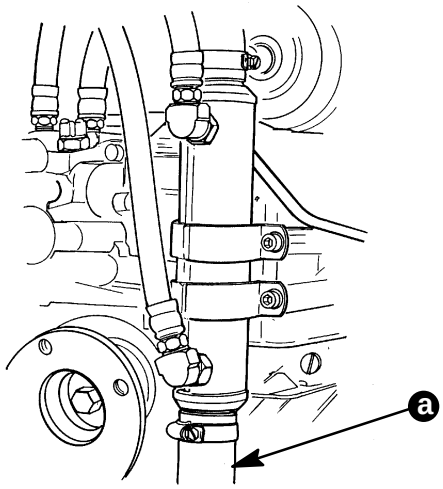


72352

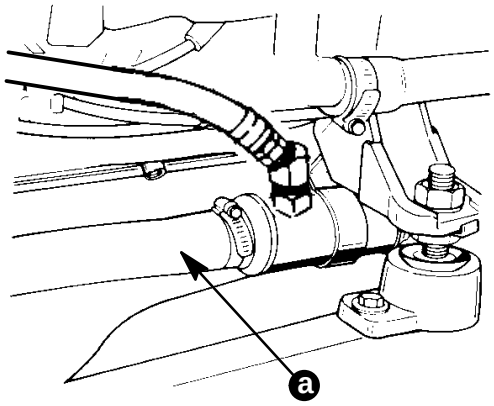
Engines WIth Cool Fuel System

a - Seawater Inlet Hose
b - Hose To Cooler

7. Remove the transmission fluid cooler hose as shown.



72721



71782

Typical Transmission Fluid Cooler Locations

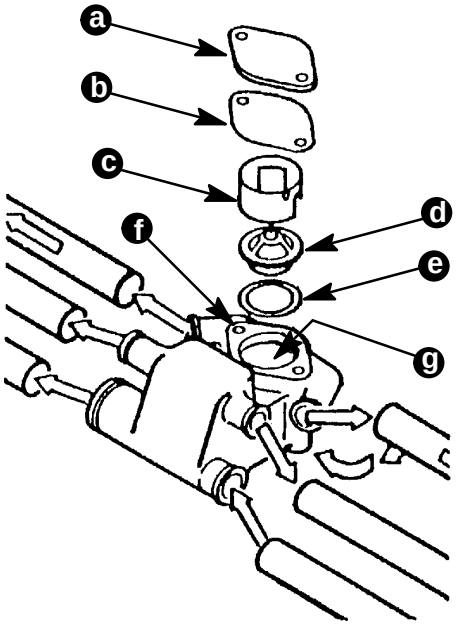
a - Hose

8. Crank engine over slightly with starter motor to purge any water trapped in seawater pickup pump. DO NOT ALLOW ENGINE TO START.
9. After cooling system has been drained completely, coat threads of drain plugs with Quicksilver Perfect Seal. Install all drain plugs and tighten securely. Reconnect all hoses and tighten all hose clamps securely.

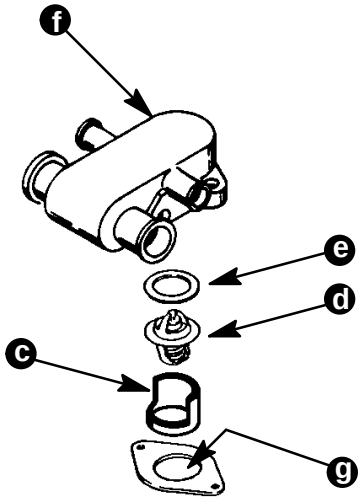
IMPORTANT: MerCruiser recommends that propylene glycol antifreeze (nontoxic and biodegradable, which makes it friendly to lakes and rivers) be used in sea-water section of the cooling system for cold weather or extended storage. Make sure that the propylene glycol antifreeze contains a rust inhibitor and is recommended for use in marine engines. Be certain to follow the propylene glycol manufacturer's recommendations.

10. For additional assurance against freezing and rust, remove the thermostat cover and thermostat. Fill the engine seawater cooling system with a mixture of antifreeze and tap water mixed to manufacturer's recommendation to protect engine to the lowest temperature to which it will be exposed during cold weather or extended storage. Using a new gasket, reinstall thermostat and cover. Tighten cover bolts to 30 lb. ft. (41 N·m).

NOTE: *Hoses shown removed only to indicate flow. Do not remove hoses.*



72589



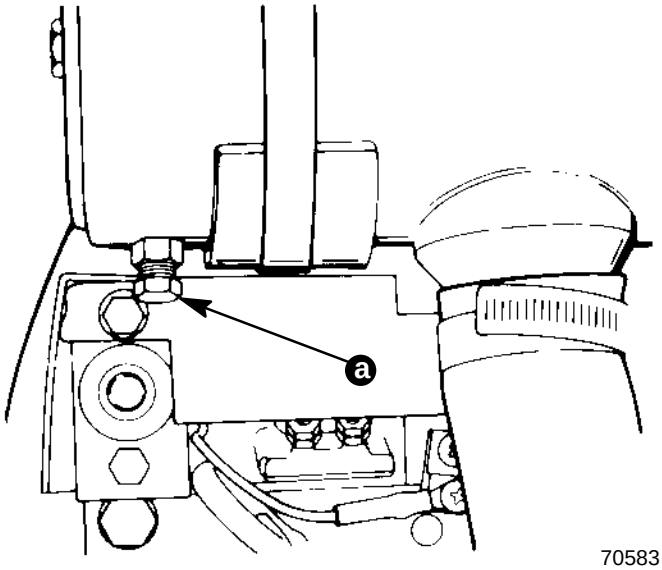
a - Cover
b - Gasket
c - Spacer
d - Thermostat
e - O-Ring
f - Housing
g - Fill Here

DRAINING SEAWATER SECTION OF CLOSED COOLING (COOLANT) MODELS

MCM (Stern Drive) Models:

NOTICE
Refer to "Cold Weather or Extended Storage," "Precautions," in this section, BEFORE proceeding.

1. Engine must be as level as possible to ensure complete draining of cooling system.
2. **Remove** drain plug from heat exchanger.



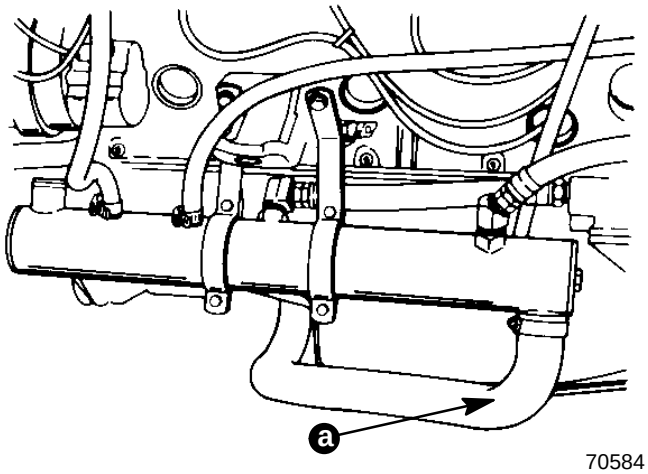
70583

a - Heat Exchanger
b - Drain Plug

3. **Repeatedly** clean out drain holes using a stiff piece of wire. Do this until entire system is drained.

NOTE: *It may be necessary to lift, bend, or lower hoses to allow water to drain completely when hoses are disconnected.*

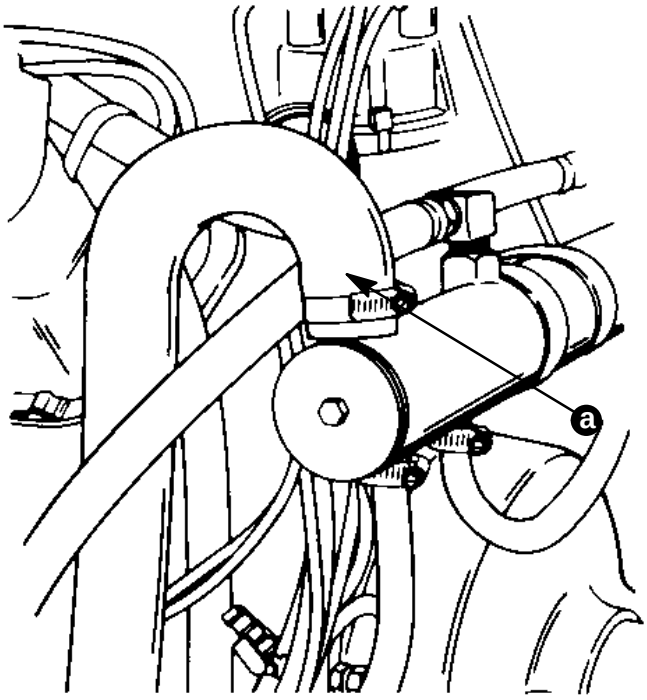
4. Remove hose from engine oil/power steering fluid cooler as shown.



70584

7.4L/454 Magnum Engine

a - Hose, Oil Cooler To Heat Exchanger

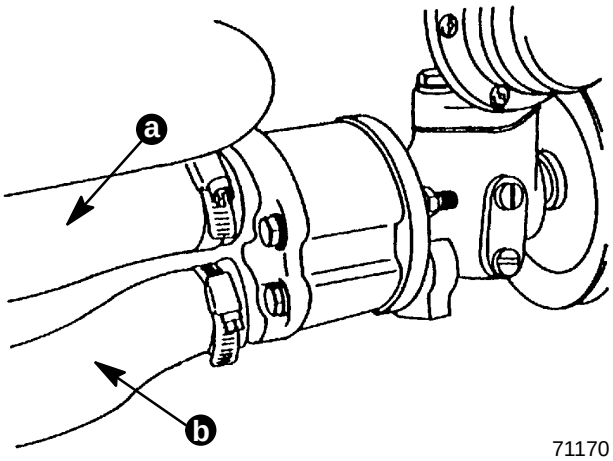


70585

502 Magnum Engine

a - Hose, Oil Cooler To Heat Exchanger

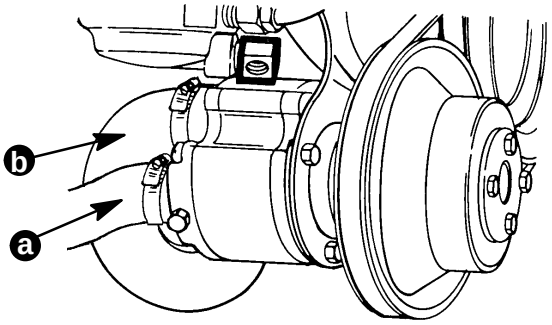
5. Remove seawater pump inlet hose as shown.



71170

Engines With Combination Seawater / Mechanical Fuel Pump

a - Seawater Inlet Hose
b - Hose To Cooler



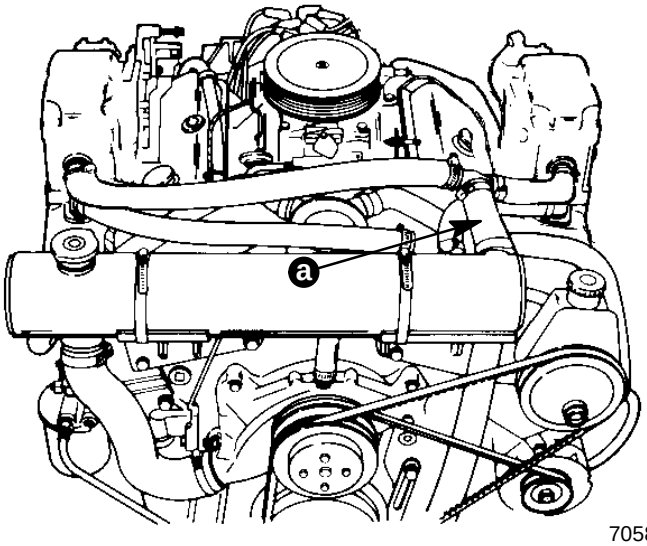
72352

Engines With Cool Fuel System

a - Seawater Inlet Hose
b - Hose To Cooler

6. Follow instructions “a” or “b”:

   a. **On Engines Without Risers:** Disconnect “T”-fitting-to-heat exchanger hose from heat exchanger.

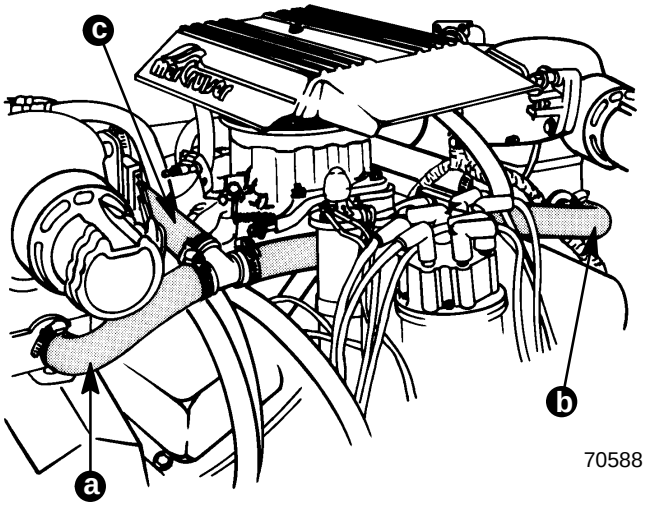


70586

Typical Engine Without Risers Shown

a - Hose, Heat Exchanger To T-Fitting

   b. **On Engines With 3 in. (76 mm) or 6 in. (152 mm) Risers And Hoses Routed to Riser Fitting Pointed Toward Flywheel End:** Remove heat exchanger-to-riser hose from port and starboard riser and remove heat exchanger-to-“T” fitting hose from heat exchanger.

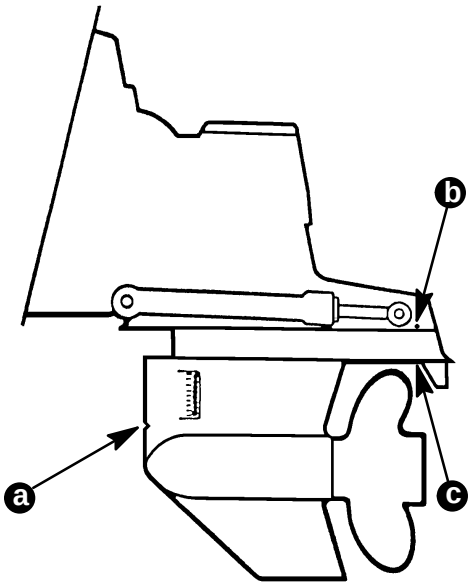


70588

Typical Engine With Risers Shown

a - Hose, Heat Exchanger To Port Riser
b - Hose, Heat Exchanger To Starboard Riser
c - Hose, Heat Exchanger To T-Fitting

7. **On Bravo Drive Equipped Models:** Insert a small wire (repeatedly) to make sure that speedometer pitot tube, trim tab cavity vent hole, and trim tab cavity drain passage are unobstructed and drained.



71217

Typical Bravo Drive Unit

a - Speedometer Pitot Tube
b - Trim Tab Cavity Vent Hole
c - Trim Tab Cavity Drain Passage

8. Crank engine over slightly with starter motor to purge any water trapped in seawater pickup pump. DO NOT ALLOW ENGINE TO START.
9. After seawater section of cooling system has been drained completely, coat threads of drain plugs with Quicksilver Perfect Seal. Install all drain plugs and tighten securely. Reconnect all hoses and tighten all hose clamps securely.

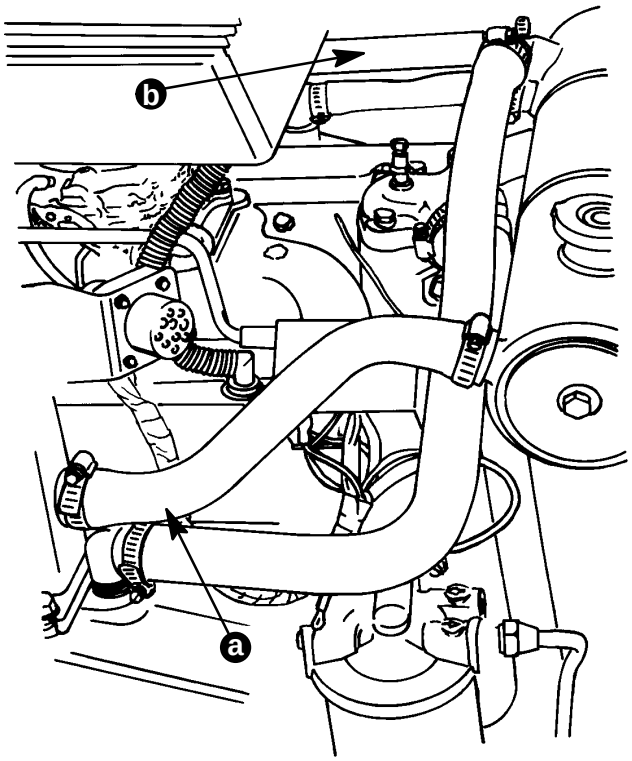
MIE (Inboard) Models

NOTICE
Refer to "Cold Weather or Extended Storage," "Precautions," in this section, BEFORE proceeding.

1. Engine must be as level as possible to ensure complete draining of cooling system.

NOTE: *It may be necessary to lift, bend, or lower hoses to allow water to drain completely when hoses are disconnected.*

2. **On Engines Without Risers:** Disconnect port and starboard heat exchanger-to-exhaust elbow hoses and lower to drain.

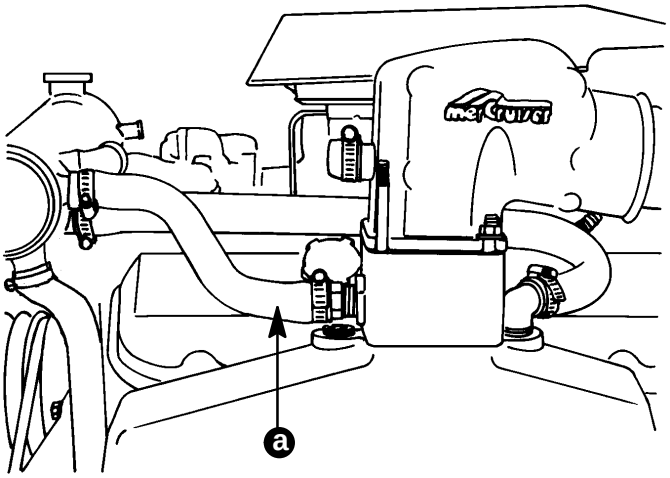


71504

Typical Engine Without Risers

a - Hose, To Starboard Exhaust Elbow
b - Hose, To Port Exhaust Elbow

3. **On Engines with 3 in. (76 mm) or 6 in. (152 mm) Risers:** Remove heat exchanger-to-riser hose from port and starboard riser.

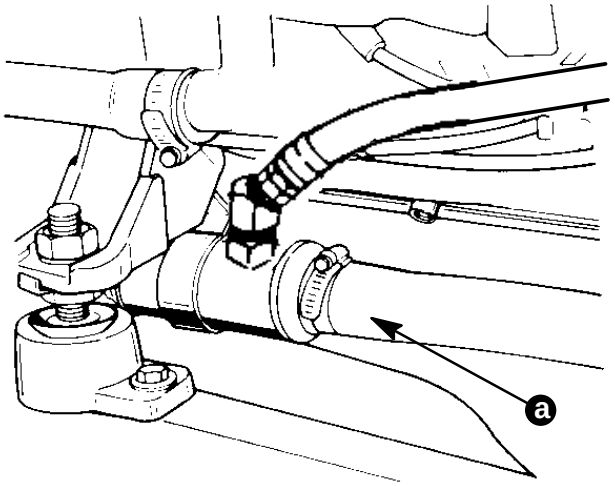


71507

Typical Engine With 3 in. (76mm) Riser [Starboard Similar; 6 in. (152mm) Risers Similar]

a - Hose, Heat Exchanger To Riser Fitting

4. Disconnect and lower oil cooler-to-heat exchanger hose from oil cooler, as appropriate on your engine.

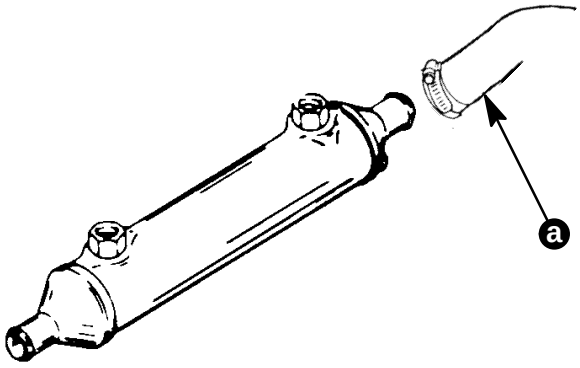


71782

7.4L Engine With Rear Mounted Heat Exchanger (Velvet Drive In-Line and V-Drive Transmissions)

a - Hose, Oil Cooler To Heat Exchanger

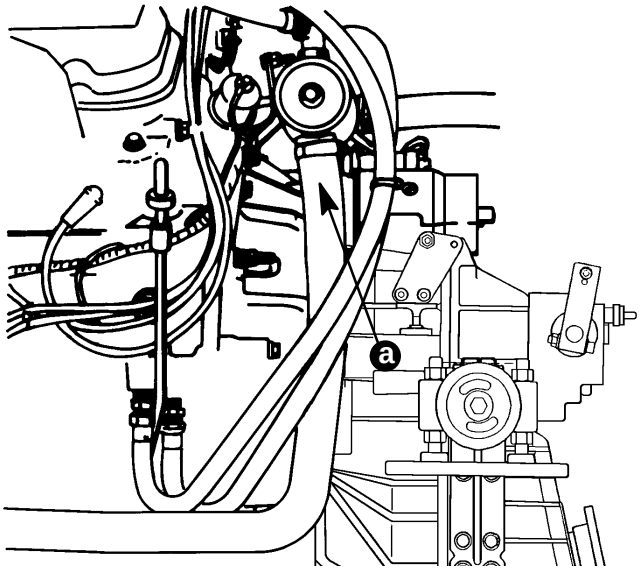
NOTE: *Engine oil cooler is mounted beneath rear mounted heat exchanger tank.*



71447

7.4L Engine With Rear Mounted Heat Exchanger (Hurth Transmission)

a - Hose, Oil Cooler To Heat Exchanger

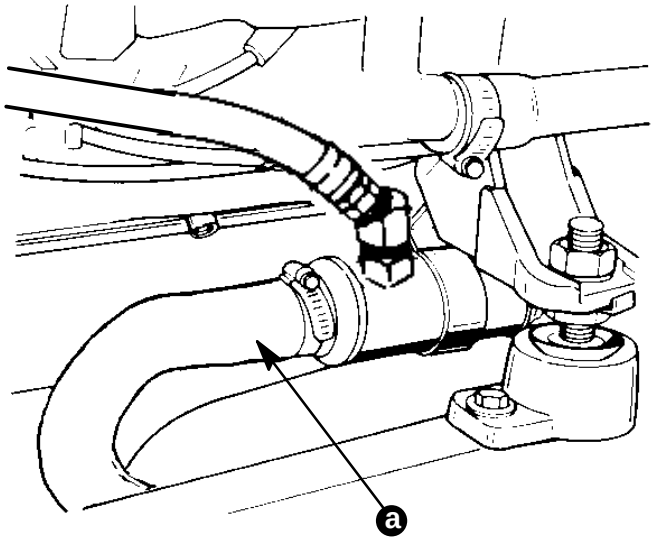


71517

7.4L / 8.2L Engine With Front Mounted Heat Exchanger

a - Hose, Oil Cooler To Heat Exchanger

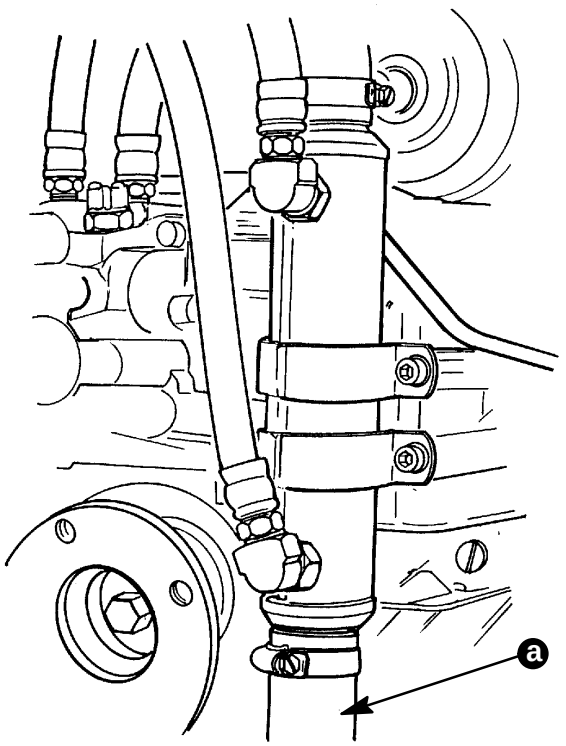
5. Remove the transmission fluid cooler hose, as appropriate on your engine, to drain hose and cooler.



71782

7.4L Engine With Rear Mounted Heat Exchanger (Velvet Drive In-Line and V-Drive Transmissions)

a - Hose, Transmission Cooler To Oil Cooler

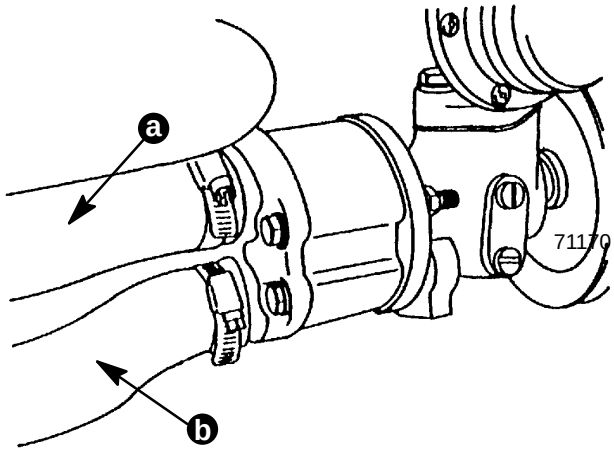


72721

Typical Hurth Transmission

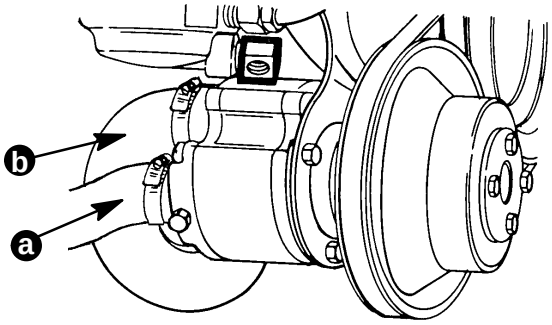
a - Hose, Transmission Fluid Cooler

6. Remove seawater pump inlet hose as shown.



Engines Combination Seawater Pump / Mechanical Fuel Pump

a - Seawater Inlet Hose
b - Hose To Cooler



72352

Engines With Cool Fuel System

a - Seawater Inlet Hose
b - Hose To Cooler

7. Crank engine over SLIGHTLY, with starter motor, to purge any water trapped in seawater pickup pump. DO NOT ALLOW ENGINE TO START.
8. After seawater section of cooling system has been drained completely, coat threads of drain plugs with Quicksilver Perfect Seal. Install all drain plugs and tighten securely. Reconnect all hoses and tighten all hose clamps securely.

Recommissioning

NOTICE
Refer to "Cold Weather or Extended Storage," "Precautions," in this section, BEFORE proceeding.

1. Check that all cooling system hoses are connected and tight and all petcocks and drain plugs are installed and tight.
2. Inspect all drive belts.
3. Perform all lubrication and maintenance specified for completion "At Least Once Yearly" in maintenance chart, except items which were performed at time of engine layup.
4. For drive unit, refer to appropriate stern drive manual.

⚠CAUTION

When installing battery (in next step), be sure to connect positive battery cable to positive (+) terminal and negative (grounded) battery cable to negative (–) battery terminal. If battery cables are reversed, damage to electrical system WILL result.

5. Install fully charged battery. Clean battery cable clamps and terminals to help retard corrosion.
6. Start engine and closely observe instrumentation to ensure that all systems are functioning properly.
7. Carefully inspect entire engine for fuel, oil, water and exhaust leaks.
8. Check fuel pump sight tube.
9. Check steering system and shift and throttle controls for proper operation.

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THIS PAGE IS INTENTIONALLY BLANK TO ALLOW FOR CORRECTIONS OR ADDITIONS AT A LATER DATE

Cause	Special Information
1. Moisture on ignition components	1. Distributor cap or spark plug wires arcing
2. Battery, electrical connections, damaged wiring	
3. Ignition switch	
4. Shift interrupter switch (Alpha One Models Only)	
5. Shorted tachometer	5. Disconnect tachometer and try again
6. Ignition timing	
7. Spark plugs	7. Fouled, burned, cracked porcelain
8. Spark plug wires	8. Faulty insulation, broken wires
9. Cracked or dirty distributor cap	
10. Faulty ignition components	10. Check components
11. Engine synchronizer (if equipped) hooked up in series on purple ignition wire (dual engines only)	11. Synchronizers must be hooked up directly at coil terminal (parallel chute)

TROUBLESHOOTING

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Precautions

⚠WARNING

Always disconnect battery cables from battery BEFORE working on fuel system to prevent fire or explosion.

⚠WARNING

Be careful when cleaning flame arrestor and crankcase ventilation hose; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark or open flame in area when cleaning flame arrestor and crankcase ventilation hose.

⚠WARNING

Be careful when changing fuel system components; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark or flame in the area while changing fuel filter. Wipe up any spilled fuel immediately.

⚠WARNING

Avoid gasoline fire or explosion. Improper installation of brass fittings or plugs into fuel pump or fuel filter base can crack casting and/or cause a fuel leak. Follow specific procedure, given in Section 4 of this manual, for all fuel line connections.

⚠WARNING

Avoid gasoline fire or explosion. Improper installation of brass fittings or plugs into fuel pump or fuel filter base can crack casting and/or cause a fuel leak.

- **Apply #592 Loctite Pipe Sealant with Teflon to threads of brass fitting or plug. DO NOT USE TEFLON TAPE.**
- **Thread brass fitting or plug into fuel pump or fuel filter base until finger tight.**
- **Tighten fitting or plug an additional 1-3/4 to 2-1/4 turns using a wrench. DO NOT OVER-TIGHTEN.**
- **Install fuel line. To prevent over-tightening, hold brass fitting with suitable wrench and tighten fuel line connectors securely.**
- **Check for fuel leaks.**

⚠WARNING

Make sure no fuel leaks exist before closing engine hatch.

⚠CAUTION

DO NOT operate engine without cooling water being supplied to water pickup holes in gear housing, or water pump impeller will be damaged and subsequent overheating damage may result.

⚠CAUTION

DO NOT operate engine without water being supplied to seawater pickup pump on engine, or pump impeller may be damaged and subsequent overheating damage to engine may result. Engine may be operated with boat out of water, if instructions under "Running Engine with Boat Out of Water," following, are completed.

⚠WARNING

When running engine with boat out of water, be certain that area in vicinity of propeller is clear and that no person is standing nearby. As a precautionary measure, it is recommended that the propeller be removed.

⚠CAUTION

DO NOT run engine above 1500 RPM, as suction created by seawater pickup pump may collapse water supply hose and cause engine to overheat.

⚠WARNING

Be sure that engine compartment is well ventilated and that no gasoline vapors are present to prevent the possibility of a FIRE or EXPLOSION.

⚠WARNING

DO NOT leave helm unattended while performing idle speed adjustment.

Used Spark Plug Analysis

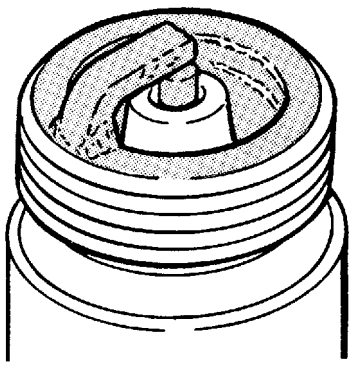
Use the following illustrations for determining serviceability of spark plug. Spark plug condition also can suggest a variety of possible engine malfunctions and, therefore, can indicate needed engine repairs. When old plugs are replaced, replace entire set. Perform plug service only on those plugs suitable for additional service, using the following procedures:

1. Remove any oil deposits with solvent and dry plugs thoroughly.
2. Open electrode gap wide enough to permit cleaning and filing.
3. Remove combustion deposits from firing end of spark plug with a plug cleaner. Blow off with compressed air to remove abrasives.
4. File electrode surfaces to restore clean, sharp edges. Again remove filings with compressed air.
5. Reset gap to specifications by bending only side electrode with proper tool.

Spark Plug Analysis

Normal Condition

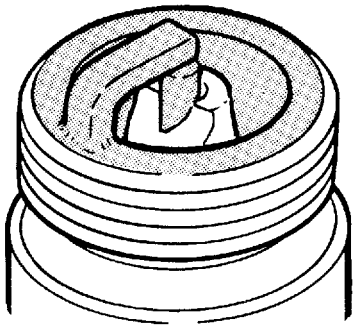
Few deposits are present and probably will be light tan or gray in color. This plug shows that plug heat range is compatible with engine, and engine is electrically and mechanically in good running condition. With proper plug servicing (clean, file and regap), this plug can be reinstalled with good results.



72420

Chipped Insulator

Chipped insulator usually results from careless plug regapping. Under certain conditions, severe detonation also can split insulator firing ends. Plug must be replaced.

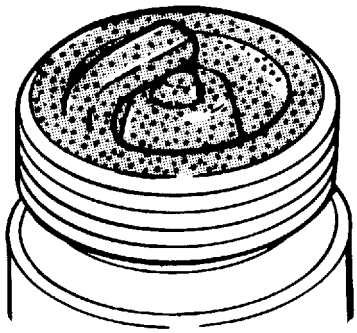


72420

Wet Fouling (Oil Deposits)

Plug becomes shorted by excessive oil entering combustion chamber, usually in engine with many hours of operation. Worn piston rings, cylinder walls, valve guides or valve stem seals are causes of oil entering combustion chamber. Only engine repairs will permanently relieve oil wet fouling.

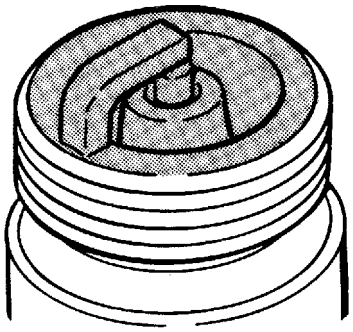
IMPORTANT: New engines or recently overhauled engines may wet foul plugs before normal oil control is achieved with proper break-in procedures. Such fouled plugs may be serviced (clean, file and regap) and reinstalled.



72420

Cold Fouling

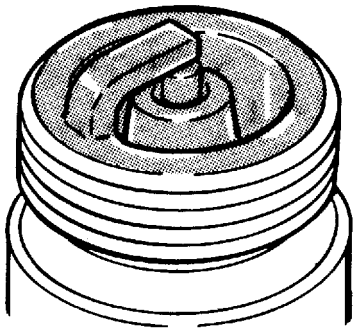
Dry, black deposits indicate rich fuel mixture or weak ignition. Clogged flame arrestor, flooding carburetor, sticky choke or weak ignition components all are probable causes. If, however, only one or two plugs in set are fouled, check for sticking valves or bad ignition leads. After correcting cause, service (clean, file and regap) plugs and reinstall.



72421

High Speed Glazing

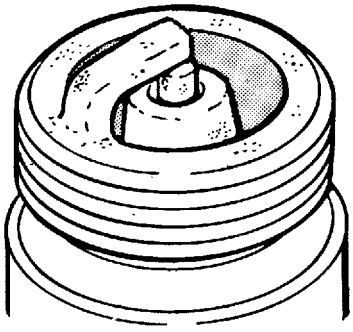
Insulator has yellowish, varnish-like color, indicating that temperatures suddenly have risen, usually during hard, fast acceleration under heavy load. Normal deposits do not get a chance to blow off. Instead, they melt and form a conductive coating. Replace plugs. If condition recurs, use colder heat range plug and service plugs more frequently.



72421

Overheating

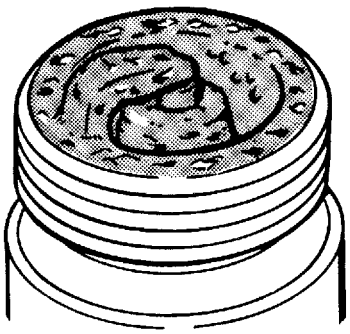
Insulator is dull white or gray and appears blistered. Electrodes are eroded and there is an absence of deposits. Check that correct plug heat range is being used. Also check for over-advanced ignition timing, cooling system malfunction, lean fuel/air mixtures, leaking intake manifold or sticking valves. Replace spark plugs.



72421

Scavenger Deposits

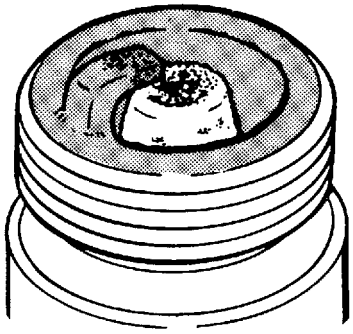
Powdery white or yellow deposits are built up on shell, insulator and electrodes. This is normal appearance with certain branded fuels. Accumulation on ground electrodes and shell areas may be unusually heavy, but may be easily chipped off. Plugs can be serviced (clean, file and regap) and reinstalled.



72422

Pre-Ignition Damage

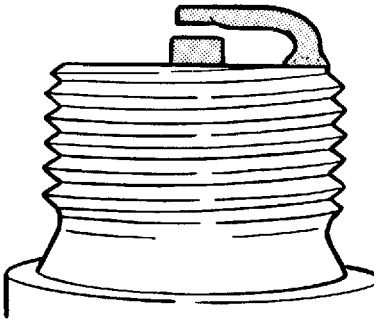
Pre-ignition damage is caused by excessive high temperatures. Center electrode melts first, followed by ground electrode. Normally, insulators are white but may be dirty if plug has been misfiring. Check for correct plug heat range, advanced ignition timing, lean fuel mixture, incorrect fuel used, malfunctioning cooling system, leaking intake manifold or lack of lubrication.



72422

Reversed Coil Polarity

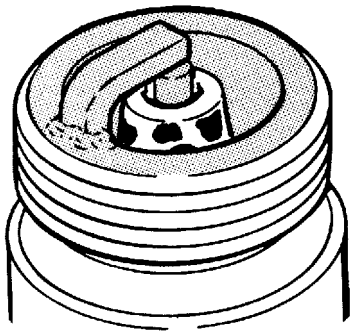
Concave erosion of ground electrode is an indication of reversed polarity. Center electrode will show only normal wear. Engine will misfire and idle rough. To correct, reverse primary coil leads. Replace spark plugs.



72422

Splashed Deposits

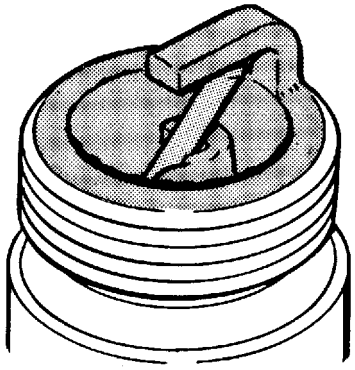
Spotted deposits, which sometimes occur after long delayed tune-up, accumulate after a long period of misfiring. When normal combustion temperatures are restored, upon installation of new plugs, deposits loosen from top of piston and head and are thrown against hot insulator. Clean and service plugs and reinstall.



72423

Mechanical Damage

Mechanical damage to spark plug firing end is caused by foreign object in combustion chamber. Because of valve overlap, small objects can travel from one cylinder to another. Check all cylinders, intake manifold and exhaust material to prevent further damage.



72423

IMPORTANT: When working on engine, spark plug holes and carburetor throat should be kept covered to prevent foreign objects from entering combustion chamber.

Poor Boat Performance and/or Poor Maneuverability

Symptom	Cause
Bow too low	A. Improper drive unit trim angle
	B. Improper weight distribution
	C. Boat is underpowered
	D. Permanent or power hook in boat bottom
	E. False bottom full of water
	F. Improperly adjusted trim tabs (after planes)
	G. Dirty boat bottom (marine growth)
Bow too high	A. Improper drive unit trim angle
	B. Propeller pitch too great
	C. Dirty boat bottom (marine growth)
	D. Poor running engine
	E. Improper weight distribution
	F. Rocker in boat bottom
	G. False bottom full of water
	H. Improperly adjusted trim tabs (after planes)
Propeller ventilating	A. Drive unit installed too high on transom
	B. Dirty or rough boat bottom
	C. Damaged propeller; pitch too small; diameter too small
	D. Keel located too close to propeller or too deep in the water
	E. Water pickup or thru hull fittings located too close to propeller
	F. Hook in boat bottom
	G. Propeller plugged up with weeds

Improper Full Throttle Engine RPM

RPM Too High

Cause	Special Information
Propeller	Damaged; pitch too low; diameter too small; propeller hub slipping.
Boat	Water pickup or thru hull fittings mounted too close to propeller (ventilation); keel located too close to propeller and/or too deep in the water (ventilation). Drive installed too high on transom; wrong gear ratio.
Operation	Unit trimmed out too far.
Engine coupler slipping	

RPM Too Low

Cause	Special Information
Propeller	Damaged; pitch too great; diameter too great.
Boat	Dirty or damaged bottom; permanent or power hook in bottom; false bottom full of water. Drive installed too low on transom; wrong gear ratio.
Operation	Unit trimmed in too far.

Engine Cranks Over but Will Not Start or Starts Hard

Important Information

1. First, determine which engine system is causing the problem. To make an engine run, basic components - fuel, spark (ignition), and compression - are required. If all three components are present, the engine should run. If any one of the three are missing, weak, or arriving at the wrong time the engine will not run.
2. Determine if there is fuel present by looking down the carburetor venturi while actuating throttle. There should be a stream of fuel coming out of the accelerator pump nozzles if the carburetor has fuel.
3. Check ignition system operation. Remove coil wire from tower on distributor cap. Hold coil wire near ground and check for spark while cranking engine over. Repeat procedure with spark plug wires. If there is spark at the spark plug wires, remove the spark plugs and make sure they are correct type and heat range, and not fouled or burned.
4. Run a compression check on engine to make sure the engine is mechanically OK.

Thunderbolt IV (HEI) Ignition (No Spark)

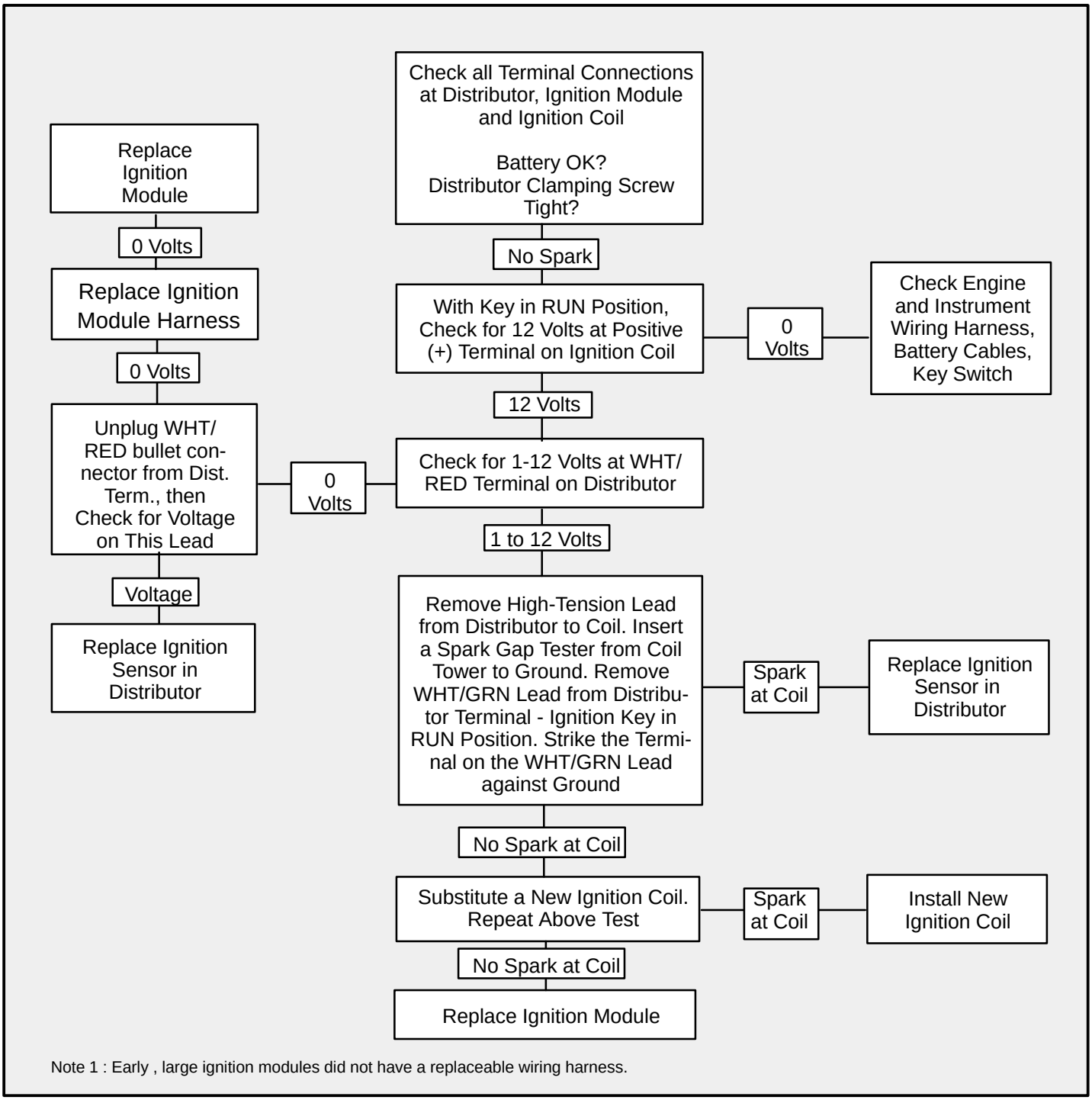
Cause	Special Information
Moisture on ignition components	Distributor cap or spark plug wires arcing
Battery, electrical connections, damaged wiring	
Ignition switch	
Shift interrupter switch (Alpha One Models Only)	
Shorted tachometer	Disconnect tachometer and try again
Ignition timing	
Spark plugs	Fouled, burned, cracked porcelain
Spark plug wires	Faulty insulation, broken wires
Cracked or dirty distributor cap	
Faulty ignition components	Check components
Engine synchronizer (if equipped) hooked up series on purple ignition wire (dual engines only)	Synchronizers must be hooked up directly coil terminal (parallel chute)

Testing Thunderbolt IV HEI System

⚠WARNING

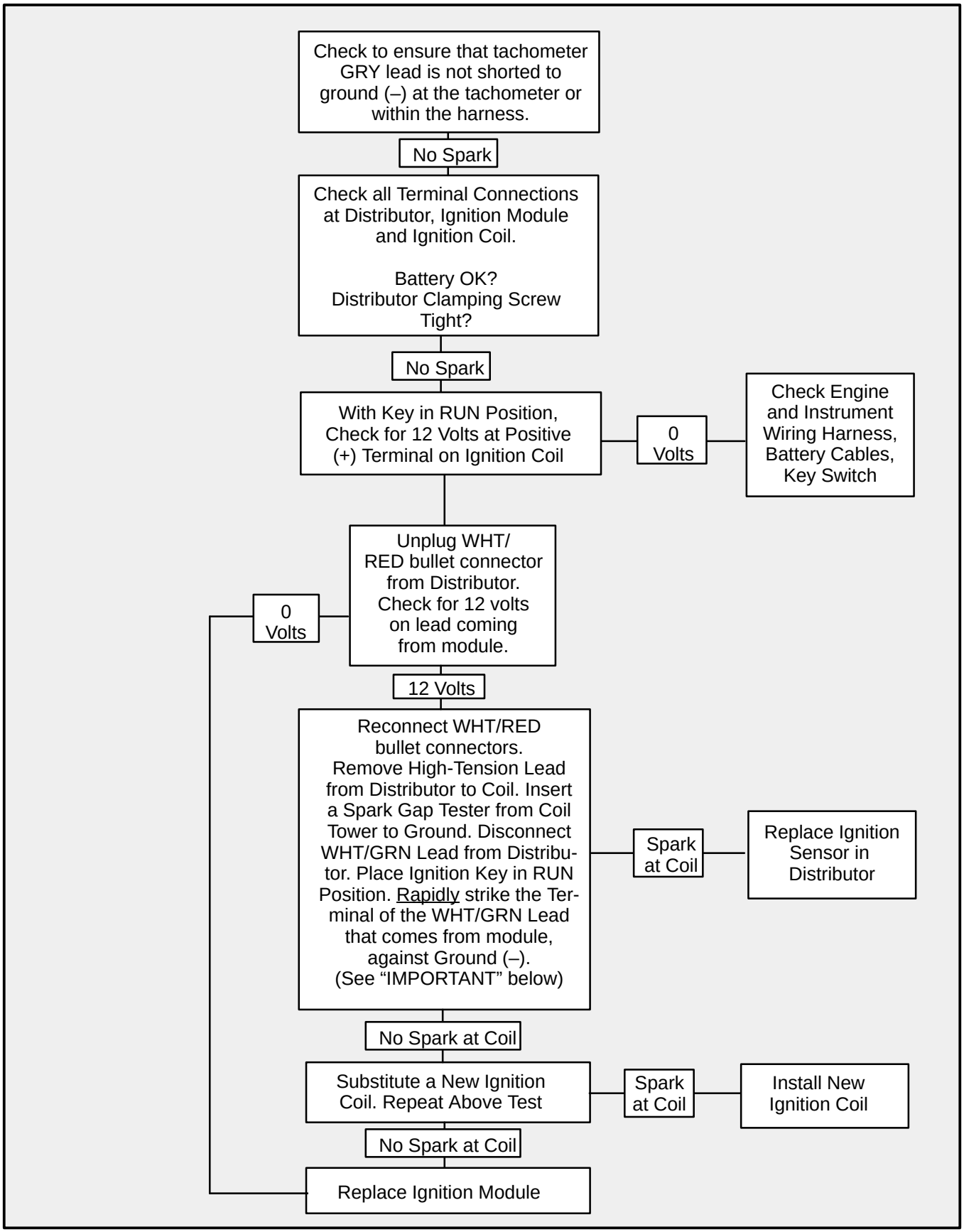
Be sure that engine compartment is well ventilated and that there are no gasoline vapors present during the following test to prevent a potential fire hazard.

IMPORTANT: Use a voltmeter when making these tests. DO NOT use a test light.



Note 1 : Early , large ignition modules did not have a replaceable wiring harness.

Testing Thunderbolt V Ignition System



IMPORTANT: The WHT/GRN lead must be touched against ground (–) 2-3 times per second to simulate a running engine. Repeat this test several times to ensure that spark is present.

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Fuel System Rich

Cause	Special Information
Warm engine carburetor percolation	Fuel boils out of float bowl when shut off and warm. Floods intake manifold.
Clogged flame arrestor	
Automatic choke not opening	
Float adjustment	
Float leaks or is saturated with fuel	
Needle and seat leaking	
Carburetor gaskets leaking	
Excessive fuel pump pressure	
Cracked or porous carburetor body	Unseats needle and seat

Fuel System Lean

Cause	Special Information
Empty fuel tank	
Fuel shut-off valve closed (if equipped)	
Vapor lock	Engine will not start after warm engine shut down
Automatic choke	Stuck open, wrong adjustment

Miscellaneous

Cause	Special Information
1. Low grade or stale fuel	
2. Water in fuel	

Engine Will Not Crank Over

Cause	Special Information
Remote control lever not in neutral position	
Battery charge low; damaged wiring; loose electrical connections	
Circuit breaker tripped	
Blown fuse	
Ignition switch	
Slave solenoid	
Faulty neutral start safety switch	Open circuit
Starter solenoid	
Starter motor	
Mechanical engine malfunction	

Charging System Inoperative

Cause	Special Information
Loose or broken drive belt	
Engine RPM too low on initial start	Rev engine to 1500 RPM
Loose or corroded electrical connections	
Faulty battery gauge	Best way to test is to replace gauge
Battery will not accept charge	Low electrolyte or failed battery
Faulty alternator or regulator	
Refer to Section 4C for complete “Charging System” diagnosis procedures	

Noisy Alternator

Cause	Special Information
Loose mounting bolts	
Drive belt	Worn, frayed, loose
Loose drive pulley	
Worn or dirty bearings	
Faulty diode trio or stator	

Instrumentation Malfunction

Cause	Special Information
Faulty wiring, loose or corroded terminals	
Faulty key switch	Test, as outlined in Section 4D
Faulty gauge	Test, as outlined in Section 4D
Faulty sender	Test , as outlined in Section 4D

Radio Noise

Cause	Special Information
A “popping” noise that will increase with engine RPM. Noise will stop as soon as engine is turned off.	Ignition System - wrong spark plugs; cracked distributor cap; cracked coil tower; leaking spark-plug wires; moisture on ignition components
“High pitched whine” in the radio	Alternator - poor brush contact on the slip rings
A “hissing or crackling” noise when instruments are jarred with ignition on	Instrumentation - loose connections, or antennae wire routed too close to instruments
Varying unexplained noises	Accessories - bilge pump, bilge blower; fish finder, depth locator; cabin heater motor, etc. Disconnect one at a time until noise disappears.

Poor Fuel Economy

Cause	Special Information
Fuel leaks	
Operator habits	Prolonged idling; slow acceleration; failure to cut back on throttle once boat is on plane; boat overloaded; uneven weight distribution
Engine laboring	Bent, damaged, or wrong propeller. Water test boat for proper operating RPM at wide-open-throttle
Clogged flame arrestor	
Engine compartment sealed too tight	Not enough air for engine to run properly
Boat bottom	Dirty (marine growth), hook, rocker
Carburetor	Idle mixture settings, accelerator pump adjustments,linkage binding, choke adjustment, carburetor flooding over, main fuel jets
Improper fuel	
Crankcase ventilation system not working	
Engine needs tune-up	
Engine running too cold or too hot	
Plugged or restricted exhaust	
Engine	Low compression

Carburetor Malfunctions

Symptoms	Cause
Flooding	A. Needle and seat
	B. Float adjustment
	C. Saturated float
	D. Gaskets leaking
	E. Cracked fuel bowl
	F. Fuel percolation
	G. Automatic choke
Rough idle	2. A. Idle RPM too low
	B. Idle mixture screws
	C. Idle passages dirty
	D. Throttle valves not closing
	E. Engine flooding
	F. Vacuum leak
	G. Throttle body heat passages plugged
Hesitation or acceleration flatness	A. Accelerator pump
	B. Leaking gaskets
	C. Automatic choke
	D. Power piston or power valve
	E. Throttle valves
	F. Throttle body heat passages plugged
	G. Main metering jets
	H. Float adjustment
	I. Secondary air valve wind-up

Engine Runs Poorly at Idle

Symptoms	Cause
Engine surges	A. Main metering jets
	B. Leaking gaskets
	C. Float adjustment
	D. Saturated float
	E. Power piston or valve
	F. Throttle valves
Low top speed or lack of power	A. Power piston or valve
	B. Float adjustment
	C. Main metering jets
	D. Leaking gaskets
Poor cold engine operation	A. Idle RPM too low
	B. Idle mixture screws
	C. Throttle valves
	D. Automatic choke
	E. Engine flooding
Engine stalls	A. Idle RPM too low
	B. Idle mixture screws
	C. Engine flooding
	D. Automatic choke
	E. Dirt in carburetor
	F. Accelerator pump
	G. Leaking gaskets
Hard starting	Refer to “Engine Starts Hard”

Engine Runs Poorly At High RPM

Cause	Special Information
Also refer to “Poor Boat Performance”	
Crankcase overfilled with oil	Check oil level with boat at rest in the water.
Anti-siphon valve (if equipped)	Restricting fuel supply
Plugged fuel tank vent	
Fuel supply	Refer to “Carburetor Malfunctions” (See “Table of Contents”)
Ignition timing	
Low grade of fuel or water in the fuel	
Spark plugs	Fouled, burned, cracked porcelain, incorrect heat range
Spark plug wires	Poor insulation, broken wires
Distributor cap or rotor	Dirty or cracked
Coil	
Distributor	Excessive play in shaft
Engine overheating	Refer to “Engine Overheats”
Low compression	Worn valves, rings, cylinders, etc.
Restricted exhaust	

Engine Acceleration Is Poor

Cause	Special Instructions
Also refer to “Poor Boat Performance”	
Idle mixture screws	
Incorrect ignition timing	
Incorrect distributor or amplifier advance curve	Refer to Section 4B
Accelerator pump	Check for stream of raw fuel from accelerator pump discharge nozzle, when opening throttle with engine shut off
Cracked or dirty distributor cap or rotor	
Vacuum leak	Intake manifold or carburetor base
Spark plugs	Fouled, burned; wrong heat range; cracked porcelain
Float adjustment	
Dirty carburetor	
Low compression	

Troubleshooting with Vacuum Gauge

Reading	Cause
Steady reading between 15-21 inches at idle RPM	Normal
Extremely low reading, but steady at idle RPM	Vacuum leak; incorrect timing; underpowered boat; faulty boat bottom
Fluctuates between high and low at idle RPM	Blown head gasket between two adjacent cylinders
Fluctuates 4 or 5 inches very slowly at idle RPM	Carburetor needs adjustment; spark plug gap too narrow; valves are sticking
Fluctuates rapidly at idle, steadies as RPM is increased	Valve guides are worn
Continuously fluctuates between low and normal reading at regular intervals at idle RPM	Burned or leaking valve

Engine Noise

Important Information

No definite rule or test will positively determine source of engine noise; therefore, use the following information only as a general guide to engine noise diagnosis.

1. Use a timing light to determine if noise is timed with engine speed or one-half engine speed. Noises timed with engine speed are related to crankshaft, rods, pistons, piston pins, and flywheel. Noises timed to one-half engine speed are valve train related.
2. The use of a stethoscope can aid in locating a noise source; however, because noise will travel to other metal parts not involved in the problem, caution must be exercised.
3. If you believe noise is confined to one particular cylinder, ground spark plug leads, one at a time. If noise lessens noticeably or disappears, it is isolated to that particular cylinder.
4. Try to isolate the noise to location in engine: front to back, top to bottom. This can help determine which components are at fault.
5. Sometimes noises can be caused by moving parts coming in contact with other components. Examples are: flywheel or coupler; exhaust flappers rattling against exhaust pipe; crankshaft striking (pan, pan baffle, or dipstick tube); rocker arm striking valve cover; and loose flywheel cover. In many cases if this is found to be the problem, a complete engine teardown is not necessary.
6. When noise is isolated to a certain area and component, removal and inspection will be required. Refer to proper sections of service manual for information required for service.
7. If noise cannot be distinguished between engine and drive unit, remove drive from boat. Run a water supply directly to engine. Run engine without the drive to determine if noise is still there.

Valve Cover Area

Location	Possible Cause
Valve cover area, timed to one-half engine speed, noise could be confined to one cylinder or may be found in any multitude of cylinders	Rocker arm striking valve cover
	Rocker arm out of adjustment
	Worn rocker arm
	Bent push rod
	Collapsed filter

Cylinder Area

Location	Possible Causes
Cylinder area, may be confined to one cylinder or found in more than one cylinder, timed to engine speed	Sticking valve
	Carbon build-up
	Connecting rod installed wrong
	Bent connecting rod
	Piston
	Piston rings
	Piston pin
	Cylinder worn

Camshaft Area

Location	Possible Causes
Camshaft area, front of engine, timed to one half engine speed	Crankshaft timing sprocket
	Timing chain
	Fuel Pump
	Valve Lifter
	Cam Bearings
Camshaft area, center of engine, timed to one half engine speed	Fuel Pump
	Valve Lifter
	Cam bearing
Camshaft area, rear of engine, timed to one half engine speed	Distributor gear
	Valve lifter
	Cam bearings
Camshaft area, throughout engine, timed to one half engine speed	Loss of oil pressure
	Valve lifters
	Cam bearings

Crankshaft Area

Location	Possible Causes
Crankshaft area, front of engine, timed to engine speed	Crankshaft timing sprocket
	Timing chain
	Main bearing
	Rod bearing
Crankshaft area, center of engine, timed to engine speed	Crankshaft striking pan or pan baffle
	Main bearing
	Rod bearing
Crankshaft area, rear of engine, timed to engine speed	Loose flywheel cover
	Loose coupler
	Loose flywheel
	Main bearing
	Rod bearing
Crankshaft area, throughout engine, timed to engine speed	Loss of oil pressure
	Main bearings
	Rod bearings

Miscellaneous

Noise	Possible Cause
Engine spark knock	Advanced timing
	Low octane fuel
	Engine running hot
	Carbon deposits in engine
Popping through carburetor	Wrong ignition timing
	Carburetor set too lean
	Faulty accelerator pump
	Vacuum leak
	Valve adjustment
	Valve timing
	Burned or stuck valve
Hissing	Vacuum leak
	Leaking exhaust (manifolds or pipes)
	Loose cylinder heads
	Blown head gasket
Whistle	Vacuum leak
	Dry or tight bearing in an accessory
Sparks jumping	Leaking high tension lead
	Cracked coil tower
	Cracked distributor cap
Squeaks or squeals	Drive belt slipping
	Dry or tight bearing in an accessory
	Parts rubbing together
Rattling in exhaust pipe area	Exhaust shutters

Oil Pressure

Cause	Special Information
Measuring oil pressure	Use a good automotive oil pressure test gauge. Do not rely on the oil pressure gauge in the boat.
Check engine oil level with boat at rest in the water	Oil level should be between the ADD and FULL marks
Oil level in crankcase above FULL mark	May cause loss of engine RPM, oil pressure gauge fluctuation, drop in oil pressure, and hydraulic valve lifter noise at high RPM
Oil level in crankcase below ADD mark	Low oil pressure; oil pressure gauge fluctuation; internal engine noise and/or damage
Change in oil pressure	This may be a normal condition. Oil pressure may read high in the cooler times of the day, and when engine is not up to operating temperature. As the air temperature warms up and engine is running at normal opening temperature, it is normal for oil pressure to drop.
Low engine oil pressure at idle	With modern engines and engine oils, low oil pressure readings at idle do not necessarily mean there is a problem. If valve lifters do not “clatter” (at idle), there is a sufficient volume of oil to lubricate all internal moving parts properly. The reason for the drop in oil pressure is that engine heat causes an expansion of the internal tolerances in the engine and, also, the oil will thinout somewhat from heat.
Low engine oil pressure at idle after running at a high RPM	Refer to No. 5 and 6, preceding
Boats with dual engines	It is not uncommon to see different oil pressure readings between the two engines, as long as both engines fall within specifications. Differences in oil pressure can be attributed to differences in engine tolerances, gauges, wiring, senders, etc.
Boats with dual stations	Refer to No. 8. preceding

Low Oil Pressure

Cause	Special Information
Low oil level in crankcase	
Defective oil pressure gauge and/or sender	Verify with an automotive test gauge. Refer to Section 4D for instrument testing.
Thin or diluted oil	Oil broken down; contains water or gas; wrong viscosity; engine running too hot or too cold; excessive idling in cold water (condensation)
Oil pump	Relief valve stuck open; pickup tube restricted; worn parts in oil pump; air leak on suction side of oil pump or pickup oil tube
Oil leak can be internal or external	Oil passage plugs leaking, cracked or porous cylinder block
Excessive bearing clearance	Cam bearings, main bearings, rod bearings

High Oil Pressure

Oil too thick	Wrong viscosity, oil full of sludge or tar
Defective oil pressure gauge and/or sender	Verify with an automotive test gauge
Clogged or restricted oil passage	
Oil pump relief valve stuck closed	

Excessive Oil Consumption

Cause	Special Information
Normal consumption.	One quart of oil consumed in 5-15 hours of operation at wide-open-throttle (especially in a new or rebuilt engine) is normal
Oil leaks	Clean bilge, run engine with clean white paper on bilge floor, locate oil leak(s)
Oil too thin	Oil diluted or wrong viscosity
Oil level too high	
Drain holes in cylinder head plugged	Oil will flood valve guides
Defective valve seals	
Intake manifold gasket leaking	
Worn valve stems or valve guides	
Defective oil cooler (if so equipped)	Crack in cooler tubes
Defective piston rings	Glazed, scuffed, worn, stuck, improperly installed; ring grooves worn; improper break-in; wrong end gap
Defective cylinders	Out of round, scored, tapered, glazed; excessive piston to cylinder clearance; cracked piston
Excessive bearing clearance	

NOTE: *ENGINE CRANKCASE OIL MUST BE CHECKED AT INTERVALS SPECIFIED IN "MAINTENANCE SCHEDULE" in Section 1B. It is normal for an engine to use a certain amount of oil in the process of lubricating and cooling the engine. The amount of oil consumption is greatly dependent upon engine speed, with consumption being highest at wide-open-throttle and decreasing substantially as engine speed is reduced.*

Water In Engine

Important Information

IMPORTANT: First determine location of water in engine. This information can be of great help when trying to determine where the water came from and how it got into the engine. The three most common problems are "water on top of pistons, water in crankcase oil, water in crankcase oil and on top of pistons."

The first step, after locating water, is to remove all the water from the engine by removing all spark plugs and pumping cylinders out by cranking engine over. Next change oil and filter. Now, start engine and see if problem can be duplicated. If problem can be duplicated, there more than likely is a mechanical problem. If the problem cannot be duplicated, the problem is either an operator error or a problem that exists only under certain environmental conditions.

If water is contained to cylinder(s) only, it is usually entering through the intake system, exhaust system, or head gasket.

If the water is contained to crankcase only, it is usually caused by a cracked or porous block, a flooded bilge, or condensation.

If the water is located in both the cylinder(s) and the crankcase, it is usually caused by water in the cylinders getting past the rings and valves, or complete submersion.

Checking for rust in the intake manifold or exhaust manifolds is a good idea. Rust in these areas will give clues if the water entered these areas.

Water on Top of Pistons

Cause	Special Information
Operator shut engine off at high RPM	
Engine "diesels" or tries to run backwards	Engine out of tune, poor fuel, high idle RPM, timing set too high
Rain water running into flame arrestor	Hatch cover
Spark plug misfiring	Improper combustion causes moisture in the air to accumulate in the cylinder
Backwash through the exhaust system	
Improper engine or exhaust hose installation	
Cracked exhaust manifold	
Improper manifold to elbow gasket installation	
Loose cylinder head bolts	
Blown cylinder head gasket	Check for warped cylinder head or cylinder block
Cracked valve seat	
Porous or cracked casting	Check cylinder heads, cylinder block, and intake manifold

Water in Crankcase Oil

Cause	Special Information
Water in boat bilge	Boat has been submerged or bilge water was high enough to run in through dipstick tube
Water seeping past piston rings or valves	Refer to “Water in Engine” (“On Top of Pistons”)
Engine running cold	Defective thermostat, missing thermostat; prolonged idling in cold water
Intake manifold leaking near a water passage	
Cracked or porous casting	Check cylinder head, cylinder block, and intake manifold

Engine Overheats (Mechanical)

Cause	Special Information
Engine RPM below specifications at wide-open-throttle (engine laboring)	Damaged or wrong propeller; growth on boat bottom;false bottom full of water
Wrong ignition timing	Timing too far advanced or retarded
Sticking distributor advance weights	
Spark plug wires crossed (wrong firing order)	
Lean fuel mixture	Refer to “Carburetor Malfunctions” in this section
Wrong heat range spark plugs	
Exhaust restriction	
Valve timing off	Jumped timing chain, or improperly installed
Blown head gasket(s)	A blown head gasket(s) normally cannot be detected by a compression check. Normally the engine will run at normal temperature at low RPM, but will overheat at speeds above 3000 RPM. **Engines that are seawater cooled**: Using a clear plastic hose, look for air bubbles between seawater pump and engine. If there are no bubbles present, install clear plastic hose between thermostat housing and manifold(s).If air bubbles are present at a higher RPM, it is a good indication there is a blown head gasket.
Insufficient lubrication to moving parts of engine	Defective oil pump, plugged oil passage, low oil level

Engine Overheats (Cooling System)

Cause	Special Information
IMPORTANT: The first step is to verify if the engine is actually overheating or the temperature gauge or sender is faulty. Loose or broken drive belt	**IMPORTANT: Best way to test gauge or sender is to replace them.**
Seawater shutoff valve partially or fully closed (if equipped)	
Clogged or improperly installed sea strainer	
Loose hose connections between seawater pickup and seawater pump inlet (models with belt driven seawater pump only)	Pump will suck air. Pump may fail to prime or will force air bubbles into cooling system.
Seawater inlet hose kinked or collapsed	
Seawater pickup clogged	
Obstruction on boat bottom causing water turbulence	Obstruction will be in front of seawater pickup, causing air bubbles to be forced into cooling system
Defective thermostat	
Exhaust elbow water outlet holes plugged	
Insufficient seawater pump operation	Worn pump impeller
Obstruction in cooling system such as casting flash, sand, rust, salt, etc.	Refer to water flow diagram for engine type being serviced
Engine circulating pump defective	
Also refer to “Engine Overheats (Mechanical)”	
IMPORTANT: In addition to previous checks, make the following checks if engine is equipped with closed cooling.	
Low coolant level	
Antifreeze not mixed properly	Antifreeze should be mixed 50/50 or maximum 60/40 (60% antifreeze, 40% water)
Heat exchanger cores plugged	
Water hoses reversed at the water distribution block	Refer to water flow diagram in Section 6

Insufficient Water Flow from Belt Driven Seawater Pickup Pump

Cause	Special Information
Drive belt	Loose, worn or broken
Seawater shutoff valve partially or fully closed	
Clogged or improperly installed sea strainer	
Loose hose connections between seawater pickup and seawater pump inlet	Pump will suck air, pump may fail to prime or will force air bubbles into cooling system
Seawater inlet hose kinked or plugged	
Seawater pickup plugged	
Obstruction on boat bottom causing water turblence.	Obstruction will be in front of seawater pickup, causing air bubbles to be forced into cooling system
Faulty seawater pump	

Power Steering

Poor, Erratic, or No Assist

Cause	Special Information
Drive belt	Worn, broken or out of adjustment
Low fluid level	
Air in system	Air leak in lines, pump, or air from installation. Refer to Section 9A for bleeding procedure.
Leaking hoses	Refer to Section 10A for bleeding procedure.
Steering cables and/or steering helm	Cable or helm partially frozen from rust or corrosion; cable over-lubricated; improper cable installation.
Binding in stern drive unit	Refer to appropriate Stern Drive Service Manual
Restriction in hydraulic hoses	Causes a loss of pressure
Control valve not positioned properly, not balanced properly, or the mounting nut is loose	
Mounting bracket adjusting screw loose or mounting tube is loose	
Faulty pump	Flow control valve may be sticking
Worn piston ring or scored housing bore in cylinder.	Causes loss of pressure
Leaking valve body or loose fitting spool	

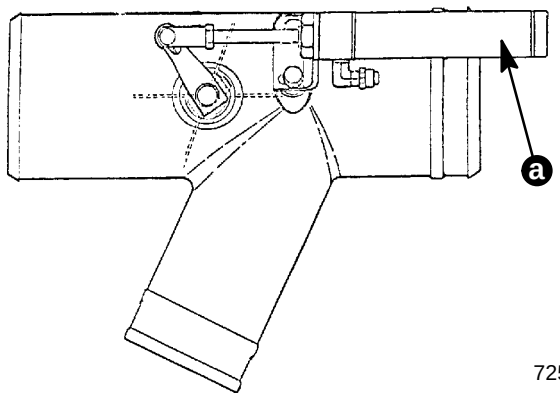
Noisy Pump

Cause	Special Information
Drive belt	Check belt tension
Low fluid level	
Air in fluid	Air leak in lines, pump, or air form installation
Faulty pump	Use stethoscope to listen for noise in pump
Restricted fluid passages	Kinks or debris in hoses or debris in passages
Stop nut adjusted improperly	Refer to appropriate Stern Drive Service Manual
Steering cables installed that do not meet BIA standards	Refer to appropriate Stern Drive Service Manual

Fluid Leaks

Cause	Special Information
Loose hose connections	Refer to Section 10A for bleeding instructions
Damaged hose	
Oil leaking from top of pump	System overfilled; fluid contains water; fluid contains air
Cylinder piston rod seal	
Faulty seals in valve	
Faulty seals in o-rings in pump	
Cracked or porous metal parts	

Troubleshooting Silent Choice Exhaust Silencer System



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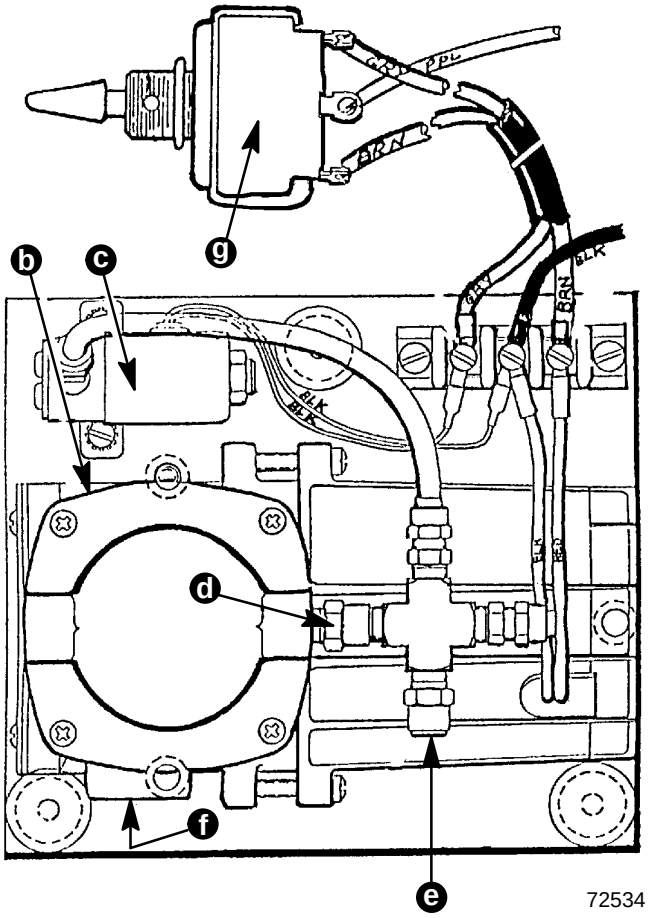


72534

a - Air Cylinder Assembly
b - Air Pump
c - Solenoid
d - Check Valve
e - Relief Valve
f - Air Intake Valve
g - Mode Switch

NOTE: *Perform the following tests with engine(s) not running.*

Compressor will not run

1. Testing mode switch (ignition switch in RUN position).
   a. Purple wire must have battery voltage. If not, fuse is blown or wiring is faulty.
   b. Brown wire must have battery voltage when mode switch is held in THRU-TRANSOM position. If not, switch is faulty.
   c. Gray wire must have battery voltage when the mode switch is held in THRU-PROP position. If not, switch is faulty.
2. Testing air pump (ignition switch in RUN position).
   a. Check that black wire, in terminal block, is grounded to engine.
   b. Brown wire in terminal block, must have battery voltage when mode switch is held in THRU-TRANSOM position. If not, wiring is faulty. If voltage is present, air pump is faulty.

Air pump runs - system inoperative

With air pump running, check hoses, fittings, solenoid, and relief valve for air leakage. Replace parts as needed.

System operates but goes THRU-PROP after air pump stops running

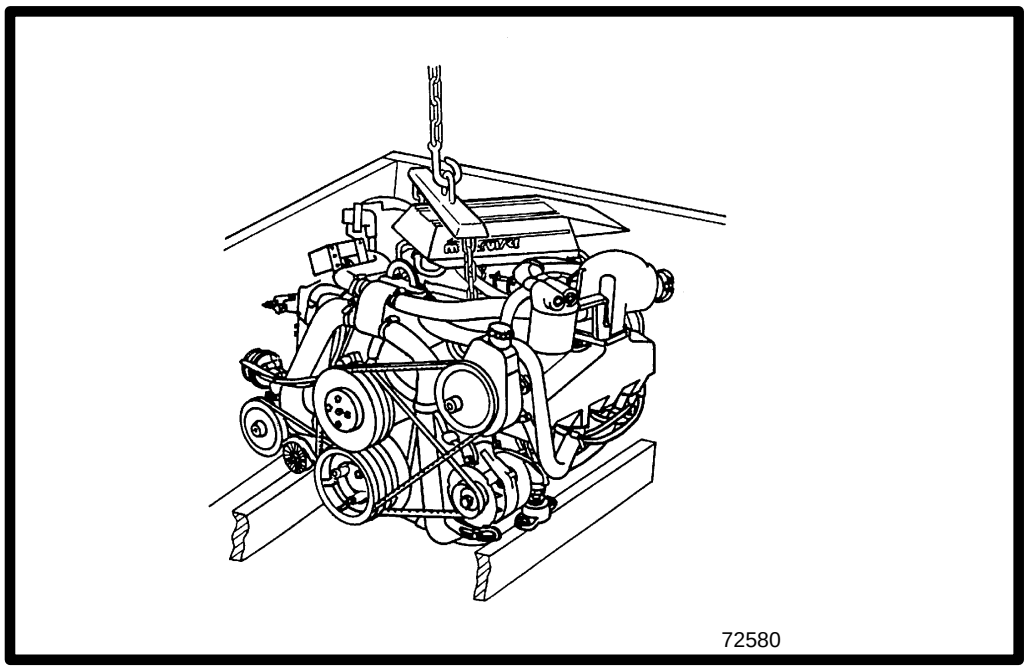
1. Check that air pressure is not leaking past solenoid. If so, replace.
2. Check that air pressure is not leaking back through air pump. If so, replace check valve.
3. Check that air pressure is not leaking at air cylinder assemblies. If so, replace faulty ones.

System stays in THRU-TRANSOM mode, will not go back to THRU-PROP mode

Gray wire, in terminal block, must have battery voltage when mode switch is held in THRU-PROP position. If not, wiring is faulty. If voltage is present, solenoid is faulty.

REMOVAL AND INSTALLATION

2
A



MCM MODELS - BRAVO AND BLACKHAWK DRIVES

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Torque Specifications

FASTENER LOCATION		Lb. In.	Lb. Ft.	N·m
Drive Unit Shift Cable	Cable Barrel	Spread Cotter Key		
	Cable End Guide	See Note		
Hose Clamps		Securely		
Rear Engine Mounts			35-40	47-54
Power Steering Fluid Hose Fitting				
Earlier Style Large			23	31
Small		100		11
Later Style			23	31
Rear Engine Mounts			35-40	47-54
Remote Control Shift Cables	Cable Barrel	Securely		
	Cable End Guide	See Note		
Remote Control Throttle Cable	Cable Barrel	Securely		
	Cable End Guide	See Note		

Note: Tighten, then back nut off one half turn.

Tools/Lubricants/Adhesives/Sealants

DESCRIPTION	PART NUMBER
Engine Alignment Tool	91-805475A1
Engine Coupler Spline Grease	91-816391A4
Liquid Neoprene	92-27511-2
Loctite Pipe Sealant With Teflon	Obtain Locally

Removal

IMPORTANT: Stern drive unit must be removed prior to engine removal. Refer to Stern Drive Service Manual.

Engine Removal

1. Disconnect battery cables from battery.
2. Remove instrument harness connector plug from engine harness receptacle after loosening clamp.

⚠WARNING

Be careful when working on fuel system. Gasoline is extremely flammable and highly explosive under certain conditions. Do not smoke or allow spark or open flame in area. Wipe up any spilled fuel immediately.

3. Using wrench to stabilize brass filter nut at fuel inlet, loosen fuel line fitting, disconnect and suitably plug fuel line to prevent fuel in tank from leaking into bilge.
4. Disconnect throttle cable from carburetor, or throttle body on Fuel Injection models, and retain locknuts and hardware.
5. Disconnect bullet connectors of trim sender wires (coming from transom assembly) from engine harness.

NOTE: *After wires are disconnected be sure to loosen them from clamps or sta-straps retaining them to engine or hoses.*

6. Disconnect MerCathode wires from MerCathode controller if mounted on engine (some models).
7. Disconnect seawater inlet hose from gimbal housing.
8. Disconnect exhaust elbow hoses (bellows).
9. Remove both shift cables from shift plate. Retain locknuts and hardware.
10. Disconnect any grounding wires and accessories that are connected to engine.
11. Disconnect (and suitably plug) fluid hoses from power steering control valve on transom.

⚠CAUTION

Center lifting eye (located on top of thermostat housing) is used for engine alignment only. DO NOT use to lift entire engine.

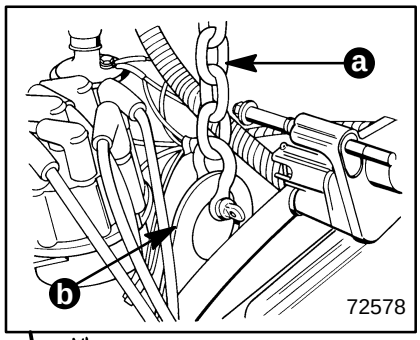
⚠CAUTION

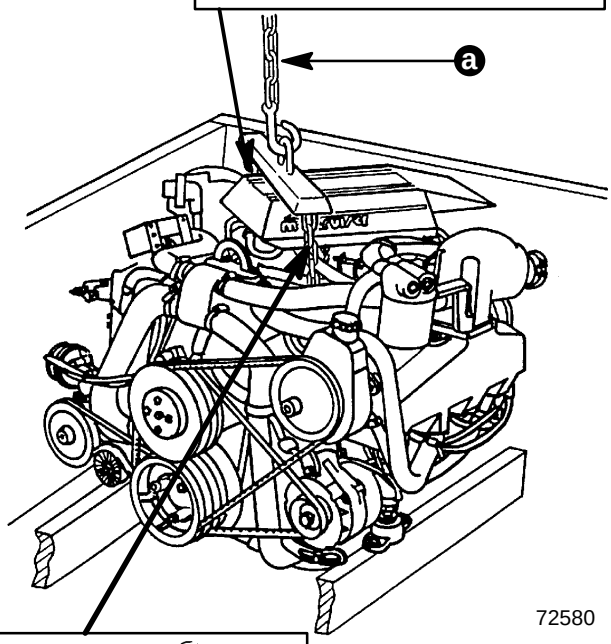
DO NOT allow lifting sling to hook or compress engine components or damage will occur.

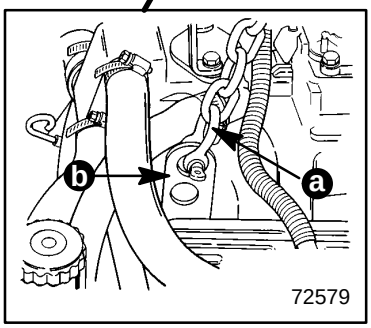
⚠CAUTION

Multi-Port engines MUST be lifted with a lifting arm or damage to engine components will occur.

12. Support engine with suitable sling through lifting eyes on engine and remove front and rear engine mounting bolts. Retain hardware.







a - Suitable Sling
b - Engine Lifting Eyes

13. Carefully remove engine. DO NOT hit power steering control valve.

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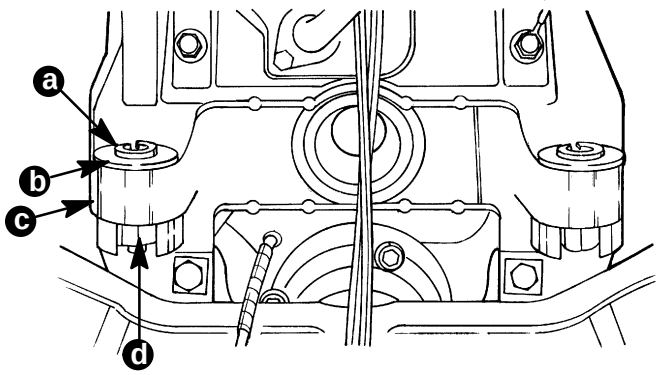
Installation

Engine Installation/Alignment

1. Follow instructions “a”- “e”:
   a. Be certain fiber washers (cemented in place) on inner transom plate are present. Inspect fiber washers. Replace if worn or damaged.
   b. Install double wound lockwashers onto inner transom plate inside fiber washer.
   c. Be certain rear engine mount locknuts are in position as shown.
   d. Lubricate exhaust bellows with soap and water to ease installation.
   e. Lubricate engine coupler splines with Quicksilver Engine Coupler Spline Grease.



72023

a - Double Wound Lockwasher
b - Fiber Wound Lockwasher (Cemented In Place)
c - Inner Transom Plate Mount (Engine Support)
d - Locknuts (Engine Mounting Bolts)

⚠CAUTION

Center lifting eye (located on top of thermostat housing) is used for engine alignment only. DO NOT use to lift entire engine.

⚠CAUTION

DO NOT allow lifting sling to hook or compress engine components or damage will occur.

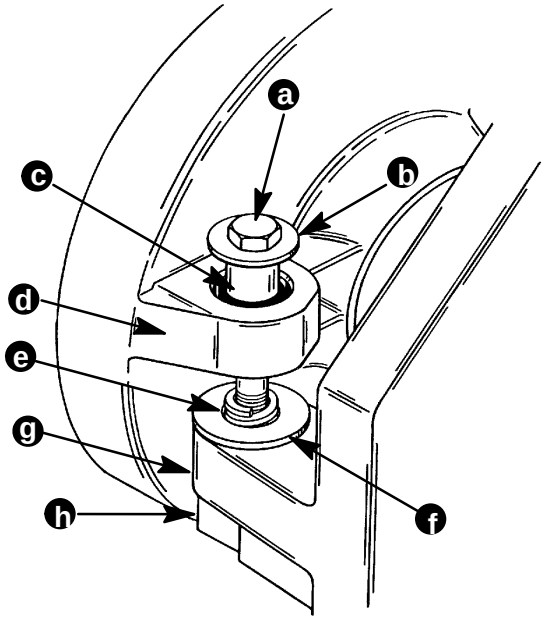
⚠CAUTION

Fuel Injection engines MUST be lifted with a lifting arm or damage to engine components will occur.

2. Attach a suitable sling to lifting eyes on engine and adjust so that engine is level when suspended. **(Refer to “Removal” section for location of lifting eyes.)**
3. Lift engine into position (in boat), using an overhead hoist.
4. Align rear engine mounts with inner transom plate mounts while simultaneously aligning exhaust tubes with exhaust pipe hoses (bellows).

IMPORTANT: Engine attaching hardware must be installed in sequence shown.

5. Install both rear engine mounting bolts and hardware as shown. Torque to 35-40 lb. ft. (47-54 N·m).



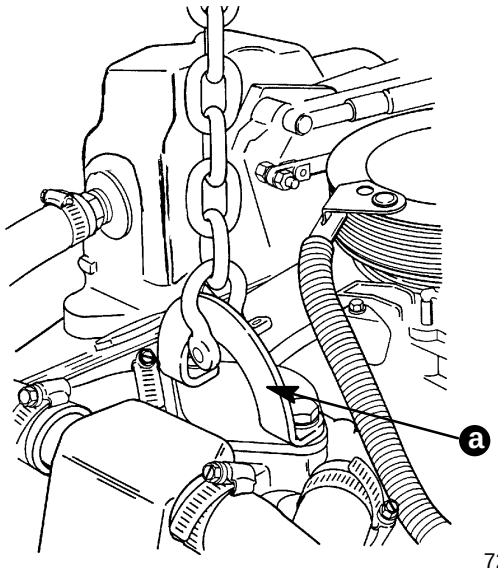
72535

a - Bolt, Rear Engine Mounting
b - Washer, Large Steel
c - Metal Spacer
d - Rear Engine Mount
e - Double Wound Lockwasher
f - Fiber Washer
g - Inner Transom Plate Mounts
h - Locknut (Hidden In This View)

⚠CAUTION

When lowering engine into position DO NOT set engine on shift cable. Shift cable outer casing can be crushed causing difficult or improper shifting.

6. Set engine down on stringers and relieve hoist tension. Disconnect sling from engine lifting eyes and switch sling to center lifting eye.



72024

a - Center Lifting Eye

⚠CAUTION

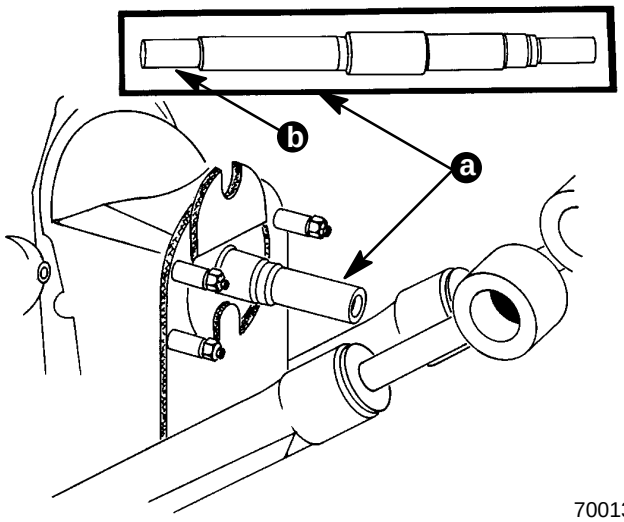
DO NOT use an alignment tool from another manufacturer. Alignment tools other than Quicksilver Alignment Tool 91-805475A1, may cause improper alignment and damage to gimbal bearing and/or engine coupler.

⚠CAUTION

To avoid damage to gimbal bearing, engine coupler, or alignment tool:

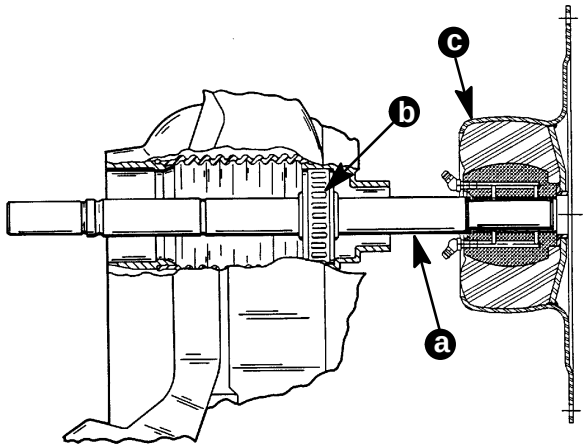
- **DO NOT attempt to force alignment tool!**
- **DO NOT raise or lower engine with alignment tool inserted (or partially inserted) in gimbal bearing or engine coupler.**

7. Align engine as follows:
   a. Attempt to insert solid end of Quicksilver Alignment Tool through gimbal bearing and into engine coupler splines. If it will not insert easily proceed to following.
   b. If the tool does not fit, remove it and carefully raise or lower the from end of the engine, as necessary, and attempt to insert the alignment tool.
   c. Repeat step “b” until the alignment tool installs easily **(SLIDES IN AND OUT FREELY WITH TWO FINGERS**) all the way into and out of engine coupler splines.



70013

a - Alignment Tool (Use Only Quicksilver Alignment Tool (91-805475A1)
b - Insert This End of Alignment Tool through Gimbal Housing Assembly



27647

a - Alignment Tool
b - Gimbal Bearing
c - Engine Coupler

IMPORTANT: Turn both front engine mount adjustment nuts an equal amount in direction required to align engine.

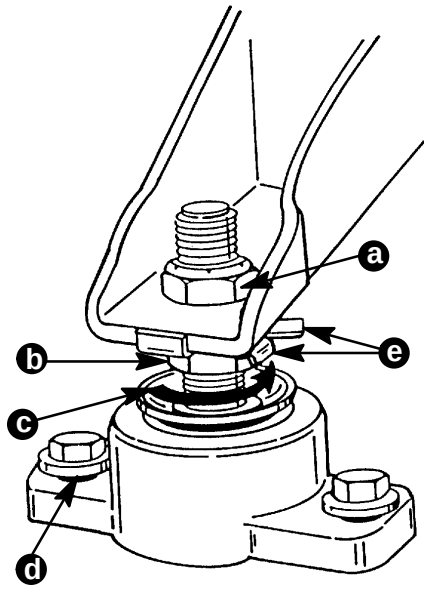
d. Adjust front engine mounts until they rest on boat stringers.

e. Relieve hoist tension entirely and fasten both front mounts to boat stringer using appropriate hardware (lag bolts or thru-bolts, etc.).

f. Recheck alignment with alignment tool. Tool must enter coupler splines freely. If not, readjust front mounts.

g. When alignment is correct, tighten locknut or nut with lockwasher on each mount securely.

h. Bend tab washer down against flat on adjusting nut.



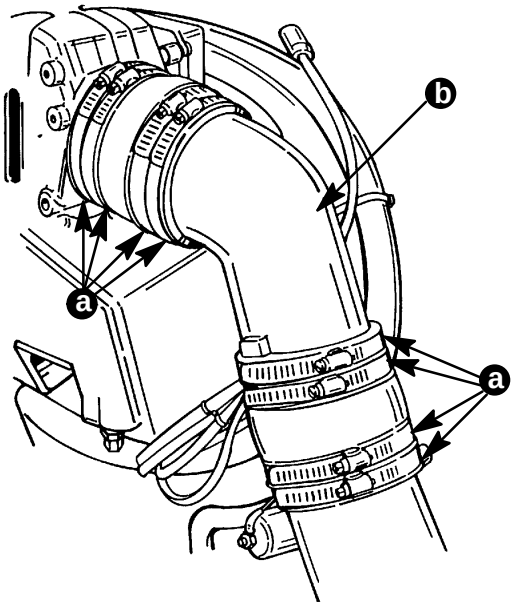
72922

a - Locknut
b - Adjustment Nut
c - Turn Adjustment Nut In This Direction (Counterclockwise) To Raise Front Of Engine
d - Slotted Hole To Front Of Engine
e - Tab Washer

i. Remove alignment tool if not already removed.

8. Tighten all exhaust system hose clamps securely as follows (use two hose clamps on each connection):

a. **On Engines with Thru-Prop Exhaust:**



72537

a - Hose Clamps - Tighten Securely
b - Exhaust Tube - Long Tube, Port Side - Short Tube, Starboard Side

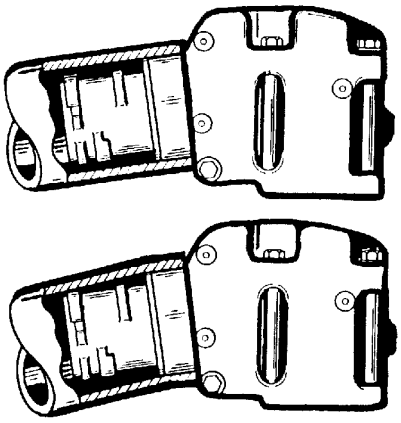
b. **On Engines with Thru-Transom Exhaust:**

NOTICE (THRU-TRANSOM EXHAUST)

Exhaust hoses must be connected to exhaust elbows so that they do not restrict the flow of discharge water from exhaust elbow. If hoses are connected incorrectly, discharge water from exhaust elbow will not flow around entire inside diameter of hose. This will cause a hot spot in the hose which may eventually burn through.

CORRECT

INCORRECT



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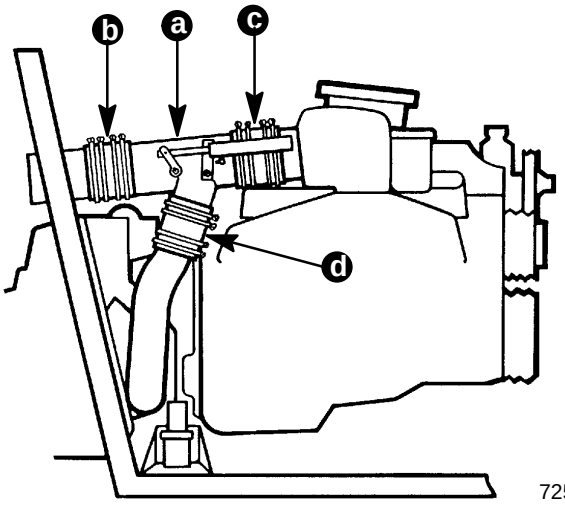
c. **On Engines with Silent Choice Exhaust System:**



72539

a - Silencer Valve
b - Exhaust Hose and Clamps For Thru Transom
c - Exhaust Hose and Clamps For Intermediate Exhaust Pipe
d - Exhaust Hose and Clamps For Exhaust Pipe

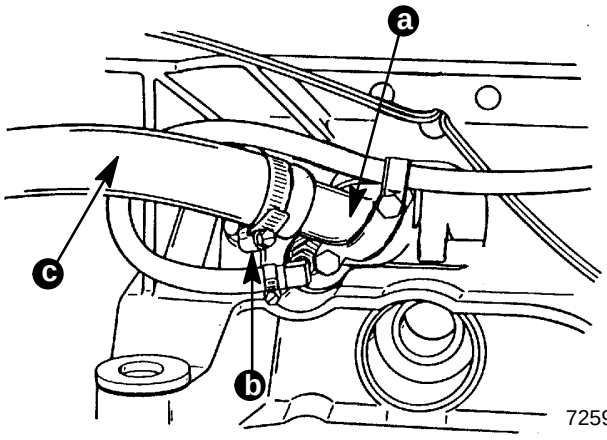
9. Proceed to “Engine Connections” section instructions following.

Engine Connections

IMPORTANT: When routing all wire harnesses and hoses, be sure they are routed and secured to avoid coming in contact with hot spots on engine and avoid contact with moving parts.

1. Connect seawater hose to water tube at gimbal housing with hose clamp. Tighten clamp securely.

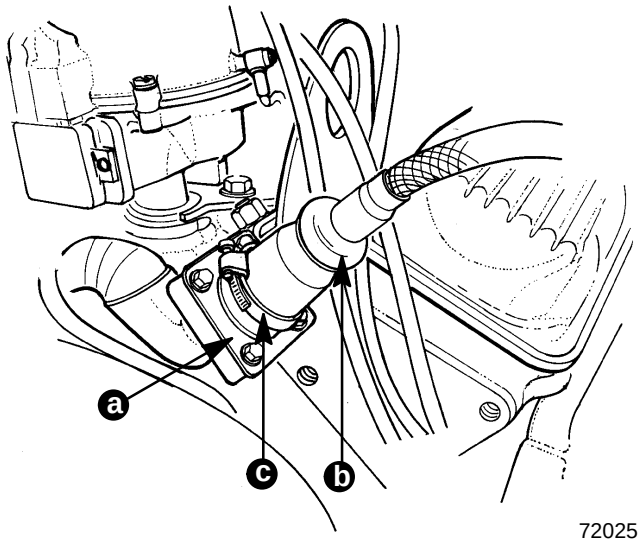
NOTE: *In the following view the engine is not in position, for visual clarity in this step.*



72590

a - Water Inlet Tube
b - Hose Clamp (Tighten Securely)
c - Seawater Inlet

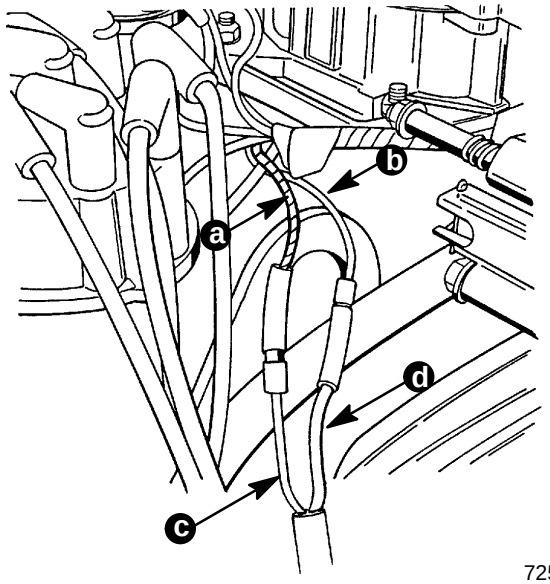
2. Connect instrument harness to engine harness with hose clamp. Tighten clamp securely.



72025

a - Engine Wiring Harness Receptacle Bracket
b - Instrumentation Wiring Harness Plug
c - Hose Clamp - Tighten Securely

3. Connect trim position sender leads from gimbal housing to leads from engine harness.



72582

a - BROWN/WHITE (From Engine Harness)
b - BLACK (From Engine Harness)
c - BLACK (From Transom)
d - BLACK (From Transom Assembly)

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⚠ WARNING

Be careful when working on fuel system. Gasoline is extremely flammable and highly explosive under certain conditions. Do not smoke or allow spark or open flame in area. Wipe up any spilled fuel immediately.

FUEL SUPPLY CONNECTIONS

⚠ WARNING

Avoid gasoline fire or explosion. Improper installation of brass fittings or plugs into fuel pump or fuel filter base can crack casting and/or cause a fuel leak.

- **Apply #592 Loctite Pipe Sealant with Teflon to threads of brass fitting or plug. DO NOT USE TEFLON TAPE.**
- **Thread brass fitting or plug into fuel pump or fuel filter base until finger tight.**
- **Tighten fitting or plug an additional 1-3/4 to 2-1/4 turns using a wrench. DO NOT OVER-TIGHTEN.**
- **Install fuel line. To prevent over-tightening, hold brass fitting with suitable wrench and tighten fuel line connectors securely.**
- **Check for fuel leaks.**

4. Connect fuel line from fuel tank(s) to engine. Make certain connections are secure. Check for leaks.
5. Connect throttle cable using hardware retained and adjust following instructions “a” or “b”:

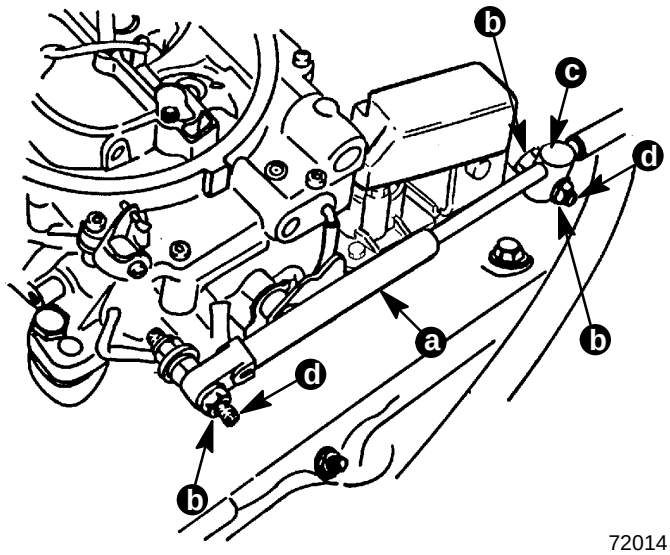
Throttle Connections

WEBER 4 BARREL CARBURETOR

1. Place remote control handle(s) in neutral, idle position.

IMPORTANT: Be sure that cable is routed in such a way as to avoid sharp bends and/or contact with moving parts. DO NOT fasten any items to throttle cable. Outer cable must be free to move when cable is actuated.

2. Install cable end guide on throttle lever, then push cable barrel lightly toward throttle lever end. (This will place a slight preload on cable to avoid slack in cable when moving remote control lever.) Adjust barrel on throttle cable to align with anchor stud.
3. Secure throttle cable with hardware (retained) as shown. Tighten cable end guide nut until it bottoms out and then back off one full turn. Tighten cable barrel securely. DO NOT OVER-TIGHTEN, as cable must pivot freely.

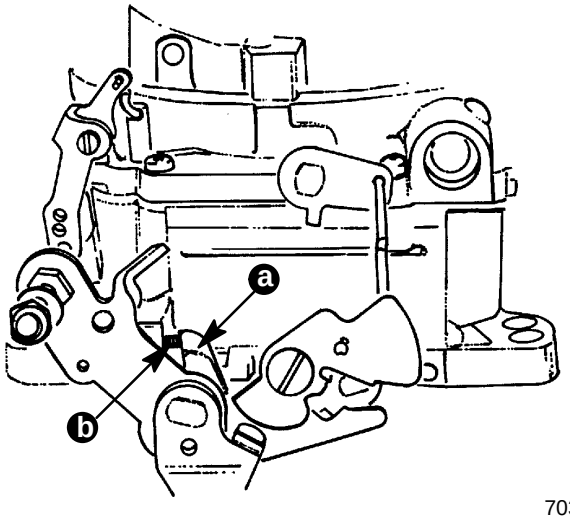


72014

a - Cable End Guide
b - Attaching Hardware (DO NOT Over-Tighten)
c - Cable Barrel
d - Anchor Studs

4. Place remote control throttle lever in the wide-open-throttle (W.O.T.) position. Check to ensure that throttle shutters (valves) are completely open and throttle shaft lever contacts carburetor body casting.

5. Return remote control throttle lever to idle position and check to ensure that throttle lever contacts idle speed adjustment screw.



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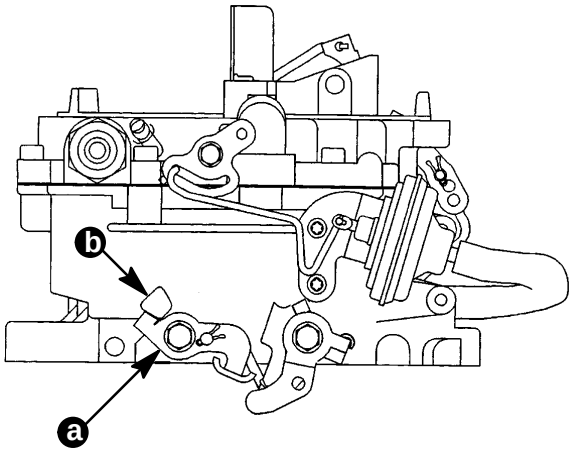
Idle Position

a - Throttle Lever Contacts (b) In idle Position
b - Idle Speed Adjustment Screw



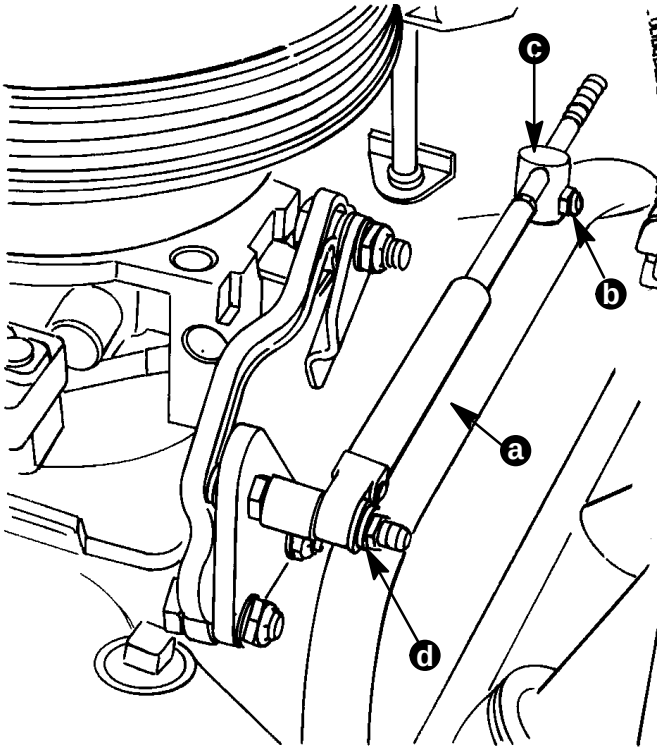
71159

Wide-Open-Throttle Position

a - Throttle Shaft Lever Contacts (b) At W.O.T. Position
b - Carburetor Body Casting

THROTTLE BODY INJECTION

1. Install cable end guide on throttle lever, then push cable barrel end lightly toward throttle lever end. (This will place a slight preload on shift cable to avoid slack in cable when moving remote control lever). Adjust barrel on throttle cable to align with hole in anchor plate.
2. Secure throttle cable with hardware as shown and tighten securely.
3. Place remote control throttle level in the wide open throttle (W.O.T.) position. Check to ensure that throttle plates are completely open.
4. Return remote control throttle lever to idle position.



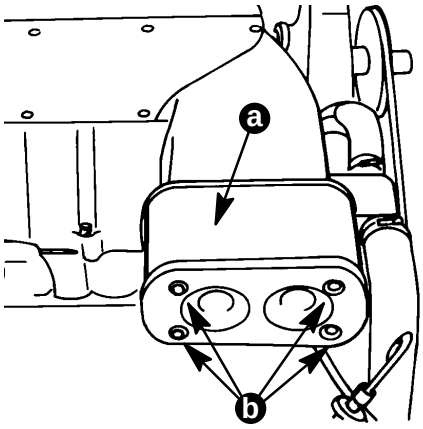
a - Cable End Guide
b - Flat Washer and Locknut - Tighten Until Bottoms Out, Then Back Off One Half Turn
c - Cable Barrel
d - Flat Washer and Locknut

MULTI-PORT INJECTION

1. Place remote control handle(s) in neutral idle position.

IMPORTANT: Be sure that cable is routed in such a way to avoid sharp bends and/or contact with moving parts. DO NOT fasten any items to throttle cable. Outer cable must be free to move when cable is actuated.

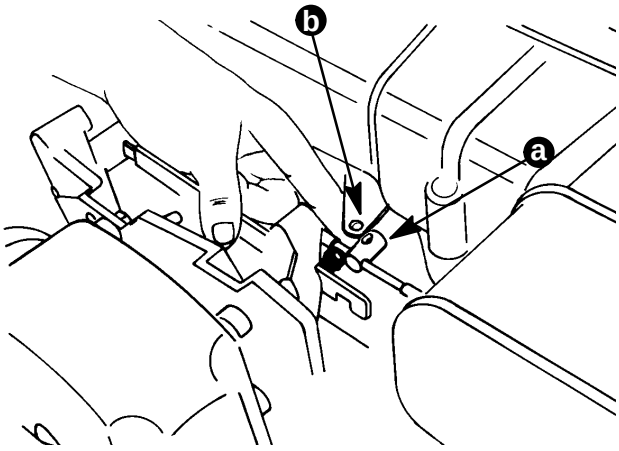
2. Remove flame arrestor.



71481

a - Flame Arrestor (Earlier Style)
b - Locknuts

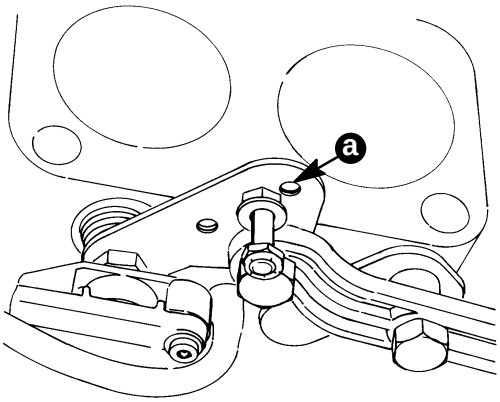
3. Install cable end guide on throttle lever, then push cable barrel end lightly toward throttle lever end. (This will place a slight preload on shift cable to avoid slack in cable when moving remote control lever). Adjust barrel on throttle cable to align with hole in anchor plate. Ensure hole in barrel positions cable as shown.



71711

a - Cable Barrel
b - Anchor Plate

NOTE: *If Boat is equipped with Quicksilver Zero Effort Controls, the throttle cable mounting stud must be most forward position on throttle lever.*

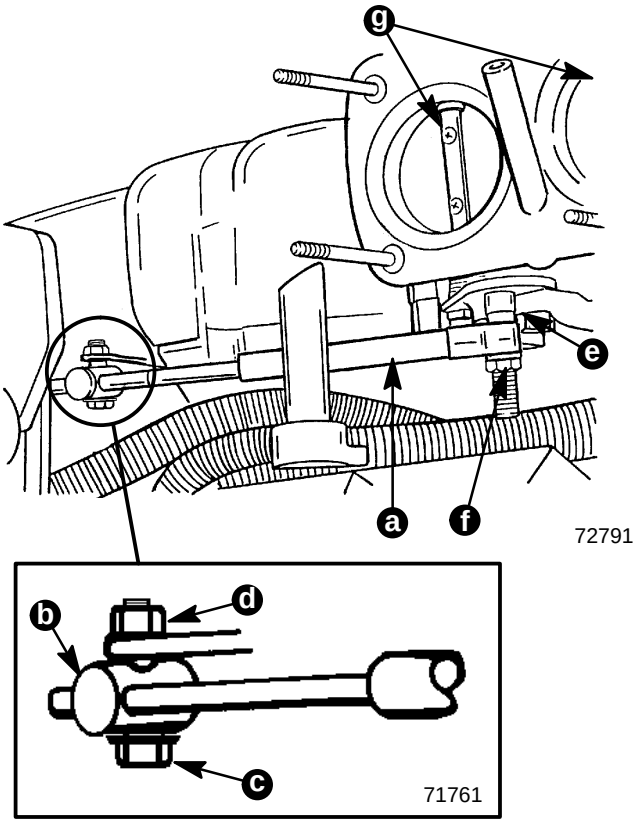


73855

a - Position For Zero Effort Controls

4. Secure throttle cable with hardware as shown and tighten securely.
5. Place remote control throttle level in the wide open throttle (W.O.T.) position. Check to ensure that throttle plates are completely open.

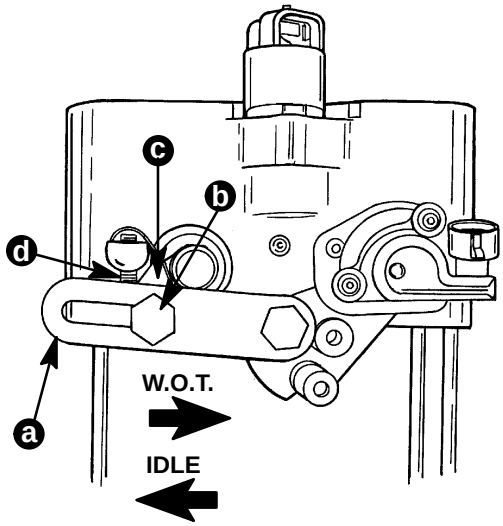
6. Return remote control throttle lever to idle position and check to ensure that throttle plates are completely closed.



72791

71761

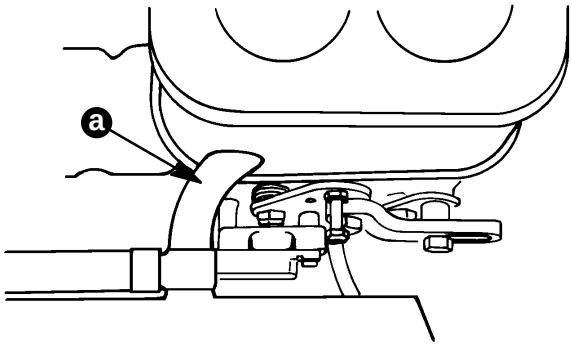
a - Cable End Guide
b - Cable Barrel
c - Bolt
d - Locknut
e - Throttle Lever
f - Flat Washer and Lockwasher
g - Throttle Plates



72794

a - Throttle Lever
b - Positive Stop Screw
c - Throttle Stop Lever
d - Throttle Stop Screw

7. Reinstall flame arrestor and tighten locknuts securely. Position crankcase vent hose against flame arrestor as shown.

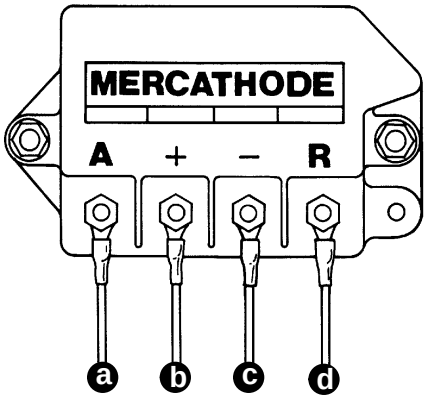


71764

a - Crankcase Vent Hose

IMPORTANT: Do not attach any accessory ground (–) wires to transom plate ground point. Accessory ground wires should only be attached to ground stud on engine.

8. Connect any grounding wires or accessories that may have been disconnected.
9. **Models with MerCathode:** Connect wires to MerCathode controller assembly as shown. Apply a thin coat of Quicksilver Liquid Neoprene to all connections.



22232

a - ORANGE Wire - From Electrode On Transom Assembly
b - RED/PURPLE Wire - Connect (Other End) to Positive (+) Battery Terminal
c - BLACK Wire - From Engine Harness
d - BROWN Wire - From Electrode on Transom Assembly

IMPORTANT: Adjust shift cables as outlined in appropriate Stern Drive Service Manual.

10. Refer to appropriate Stern Drive Service Manual and install and adjust drive unit and remote control shift cables, using hardware retained.

IMPORTANT: After fluid hose installation in the following, bleed power steering system as outlined in SECTION 1B - "Maintenance" of this manual, or refer to the appropriate Stern Drive Service Manual.

⚠ CAUTION

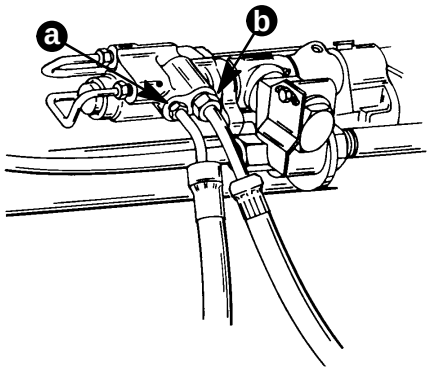
Route hoses exactly as shown below. This will help avoid stress on the hose fittings and will help avoid kinks in the hose.

IMPORTANT: Make hydraulic connections as quickly as possible to prevent fluid leakage.

IMPORTANT: Be careful not to cross-thread or over- tighten fittings.

11. Connect both hydraulic hose fittings.

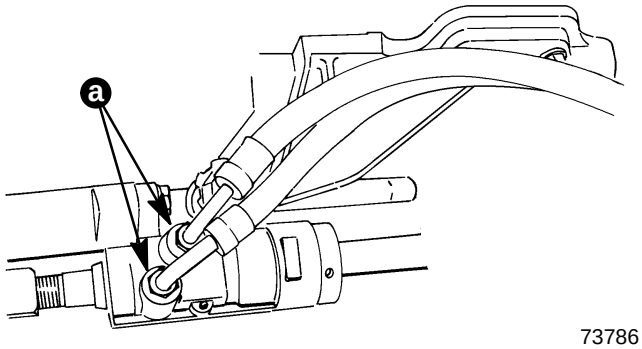
    a. **Earlier Style Control Valves:** Torque the large fitting to 23 lb. ft. (31 N·m). Torque the small fitting to 100 lb. in. (11 N·m).



22023

a - Small Fitting
b - Large Fitting

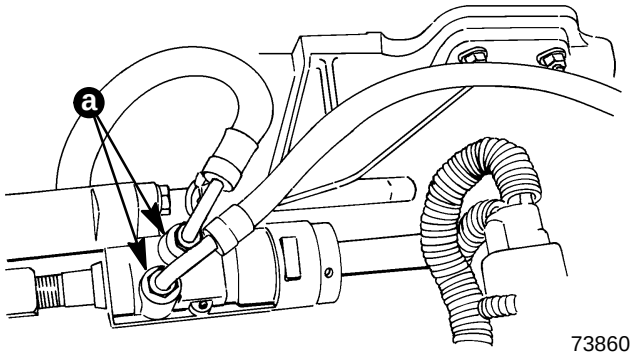
    b. **Later Style Control Valve:** Torque both fittings to 23 lb. ft. (31 N·m). Route hoses as shown for each model.



73786

All Models Except 502 EFI

a - Hose Fittings



73860

502 EFI with Oil Cooler Return Lines on the Starboard Side of the Cooler

a - Hose Fittings

12. Connect battery cables to battery by FIRST connecting positive (+) battery cable (usually RED) to positive (+) battery terminal. Tighten clamp securely. Then, connect negative (–) battery cable (usually BLACK) to negative (–) battery terminal. Tighten clamp securely.

NOTE: *Spray terminals with a battery connection sealant to help retard corrosion.*

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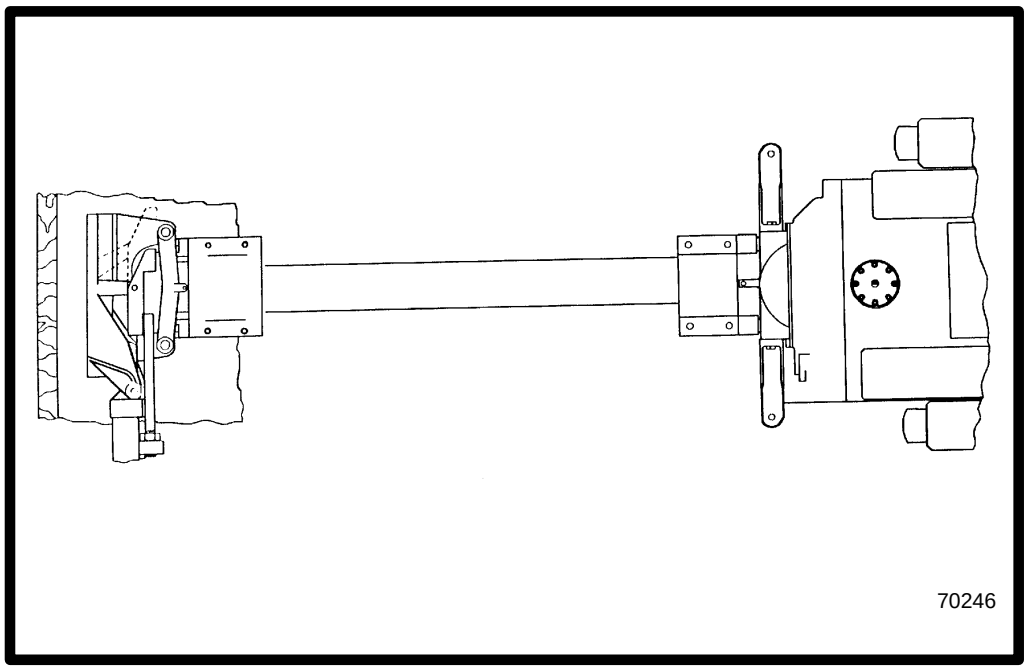
REMOVAL AND INSTALLATION

2

B



MCM MODELS - BRAVO AND BLACKHAWK DRIVES WITH DRIVESHAFT EXTENSION

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Torque Specifications

Fastener Location	Lb. Ft.	Lb. In.	N·m
Bearing Support (Tailstock) To Inner Transom Plate	35-40		47-54
Drive Shaft	50		68
Rear Engine Mount Bracket			
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Extension Housing To Flywheel Housing			
Flywheel Housing			
Early Style Power Steering Hose Fittings Large	23		31
Small		100	11
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Remote Control Throttle Cable Cable Barrel	Securely		
Cable End Guide	See Note		
Front and Rear Engine Mounts	Securely		
Hose Clamps			
Battery Cables			

NOTE: Tighten, then back nut off one-half turn

Tools / Lubricants / Sealants

Description	Part Number
Quicksilver Engine Alignment Tool	91-805475A1
Quicksilver Liquid Neoprene	92-25711-2
Quicksilver 2-4-C Marine Lubricant With Teflon	92-825407A3
Universal Protractor	Obtain Locally
Loctite Pipe Sealant With Teflon	

Removal

IMPORTANT: It is not necessary to remove the engine to service the drive shaft and/or bearing support (tailstock). Refer to instructions as outlined in Section 8E - "Drive Shaft Repair" or "Bearing Support Repair" for servicing these items only.

IMPORTANT: Stern drive unit does not have to be removed prior to engine removal. If stern drive is going to be removed, refer to appropriate Stern Drive Service Manual.

Engine Removal

1. Disconnect battery cables from battery.
2. Remove instrument harness connector plug from engine harness receptacle after loosening clamp.

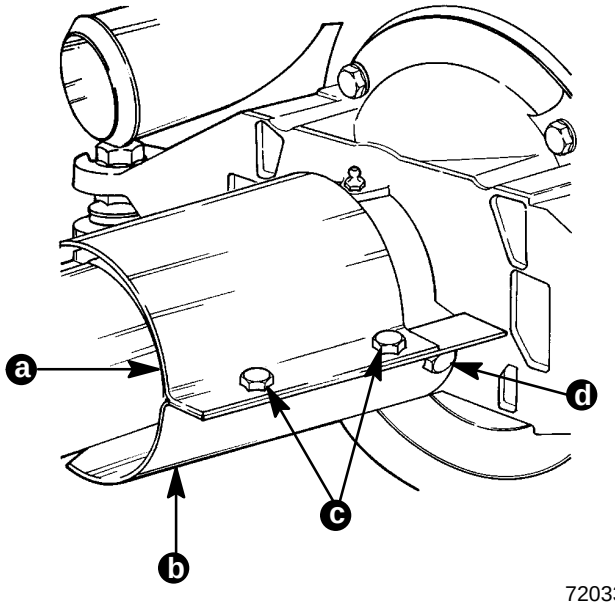
⚠WARNING

Be careful when working on fuel system. Gasoline is extremely flammable and highly explosive under certain conditions. Do not smoke or allow spark or open flame in area. Wipe up any spilled fuel immediately.

3. Using wrench to stabilize brass coupling at fuel filter inlet, loosen fuel line fitting, disconnect and suitably plug fuel line to prevent fuel in tank from leaking into bilge.
4. Disconnect throttle cable from carburetor and retain locknuts and hardware.
5. Disconnect bullet connectors of trim sender wires (coming from transom assembly) from engine harness.

NOTE: *After wires are disconnected, be sure to loosen them from clamps or Sta-Straps retaining them to engine or hoses.*

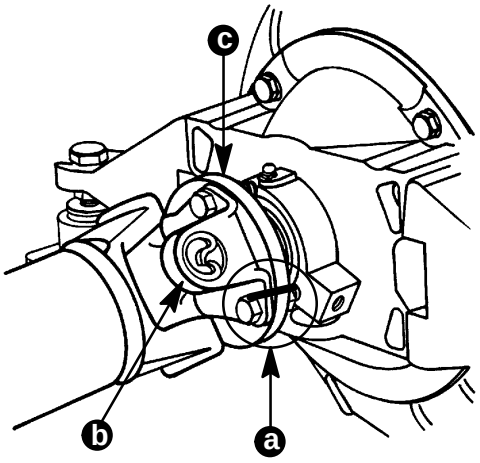
6. Disconnect MerCathode wires from MerCathode controller if mounted on engine (some models).
7. Disconnect seawater inlet hose from engine.
8. Disconnect exhaust elbow hoses (bellows).
9. Remove both shift cables from shift plate. Retain locknuts and hardware.
10. Disconnect any grounding wires and accessories that are connected to engine.
11. Disconnect (and suitably plug) fluid hoses from power steering control valve on transom.
12. Remove top and then bottom drive shaft shields at engine end of extension drive shaft.



72033

a - Top Shield
b - Bottom Shield
c - 4 Screws / Nuts (2 Hidden)
d - 3 Screws (Hidden)

13. Mark extension drive shaft U-joint yoke/output flange connections at engine end (to assist in exact same positioning during reassembly). Disconnect drive shaft from output flange.



70237

Engine End Shown

a - Matching Parts On Flange and Drive Shaft Connection
b - Extension Drive Shaft U-Joint Yoke
c - Output Flange

⚠CAUTION

Center lifting eye (located on top of thermostat housing) is used for engine alignment only. DO NOT use to lift entire engine.

⚠CAUTION

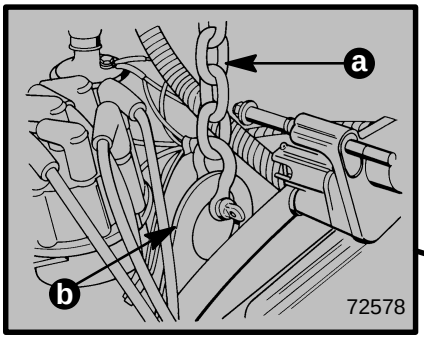
DO NOT allow lifting sling to hook or compress engine components or damage will occur.

⚠CAUTION

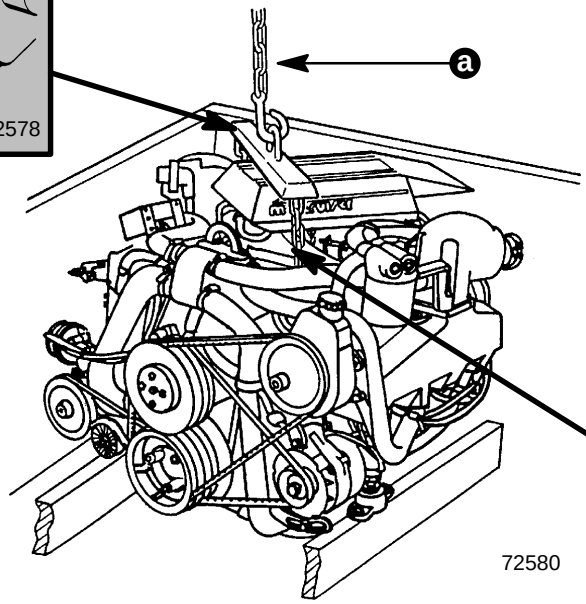
Mutli-Port Injection engines MUST be lifted with a lifting arm or damage to engine components will occur.

IMPORTANT: To avoid the need for a complete realignment (after engine repair), DO NOT MOVE FRONT AND REAR MOUNT ADJUSTMENT. Remove mounting bolts from boat stringers.

14. Support engine with suitable sling through lifting eyes on engine and remove front and rear engine mounting bolts from boat stringers. Retain hardware.
15. Carefully remove engine.



72578



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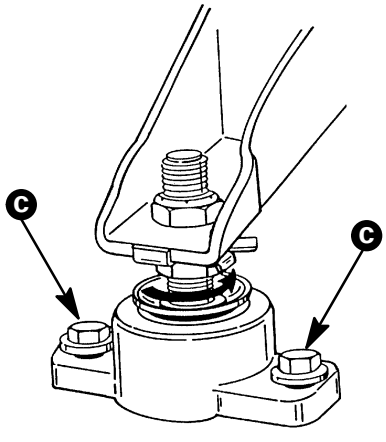
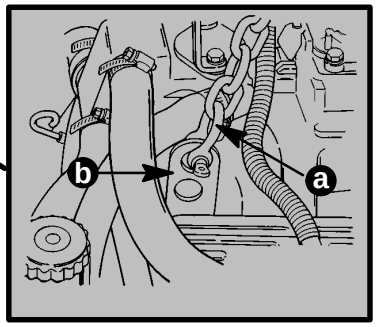


72922



Typical Mounting Shown

a - Suitable Sling
b - Engine Lifting Eyes
c - Mounting Bolts

Installation

Engine Installation/Alignment

ENGINE MOUNT ADJUSTMENT WAS NOT DISTURBED DURING SERVICE

⚠ CAUTION

Center lifting eye (located on top of thermostat housing) is used for engine alignment only. DO NOT use to lift entire engine.

⚠ CAUTION

DO NOT allow lifting sling to hook or compress engine components or damage to them will occur.

⚠ CAUTION

Multi-Port Fuel Injection engines MUST be lifted with a lifting arm or damage to engine components will occur.

1. Attach a suitable sling to lifting eyes on engine and adjust so that engine is level when suspended. **(Refer to "Removal" section for location of lifting eyes.)**
2. Lift engine into approximate position (in boat), using an overhead hoist.
3. Set engine on stringers.
4. Grease drive shaft universal joints with Quicksilver 2-4-C Marine Lubricant With Teflon.

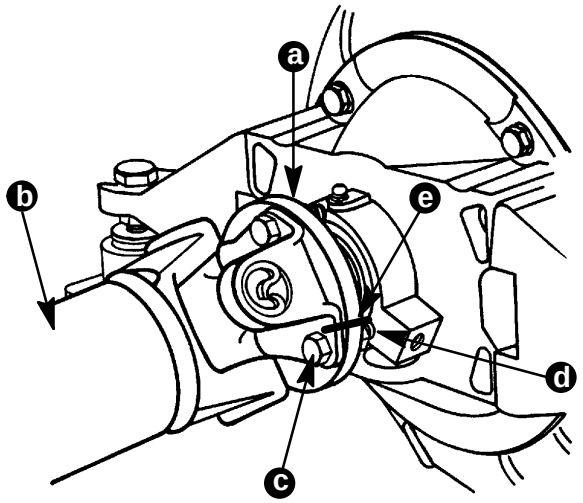
⚠ CAUTION

When attaching shaft in next step, BE SURE that the pilot on drive shaft flanges are engaged in input shaft and output shaft flanges. Flanges MUST BE flush to each other prior to tightening screws or screws may come loose during operation.

⚠ CAUTION

Failure to align shaft flanges with matching marks made on disassembly may cause improperly aligned drive unit and extension drive shaft U-joint centerlines resulting in a severe vibration problem.

5. As shown, attach engine output flange to drive shaft flange exactly as marked during disassembly. Torque fasteners to 50 lb. ft. (68 N·m).



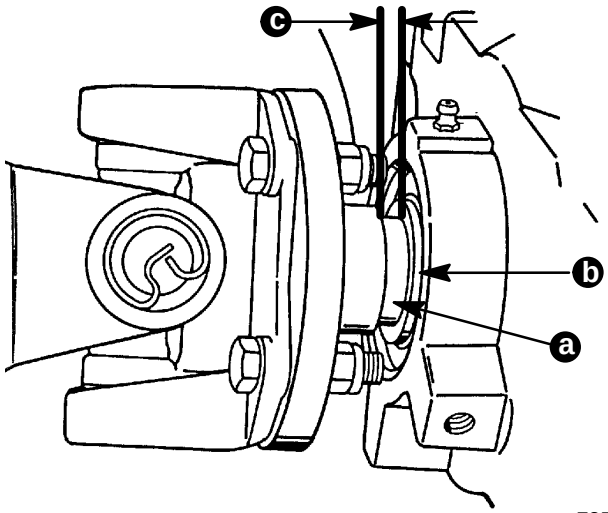
70237

Engine End Shown

a - Output Shaft Flange
b - Drive Shaft
c - Screw 7/16-20 x 1-1/2 In. (38 mm) Long (4 Used)
d - Nut 7/16-20 (4 Used)
e - Matching Marks Made Upon Disassembly - Aligned

IMPORTANT: Failure to properly position output shaft flange may result in bearing damage.

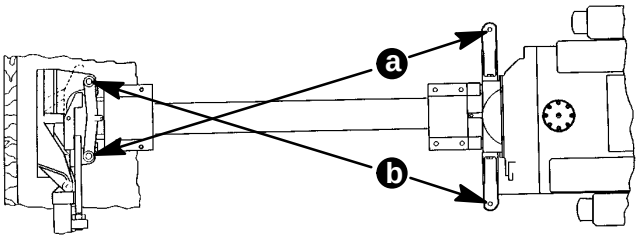
6. Relieve hoist tension from engine, then slide engine fore or aft as needed to obtain 1/4 in. (6 mm) clearance between flange shoulder and extension shaft housing bearing.



72591

a - Flange Shoulder
b - Bearing
c - 1/4 In. (6 mm)

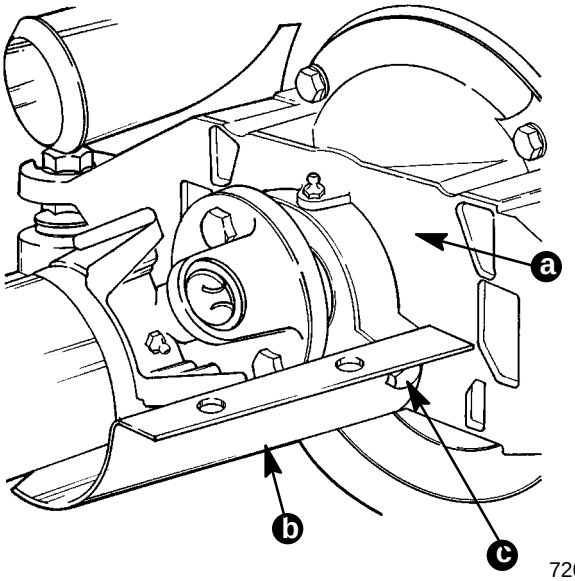
7. Position engine for correct engine and drive shaft lateral alignment as follows:
   a. Measure the length of (a) and (b) to the centers of bolt holes. They MUST BE EQUAL. If they are not equal, slide the aft and forward ends of the engine equal amounts in opposite directions to obtain equal lengths for (a) and (b).
   b. Recheck Step 6. If Step 6 is not as specified, adjust and recheck Step 7a. Continue this process until both Steps 6 and 7a are as specified.



70246

These Dimensions Must Be Equal

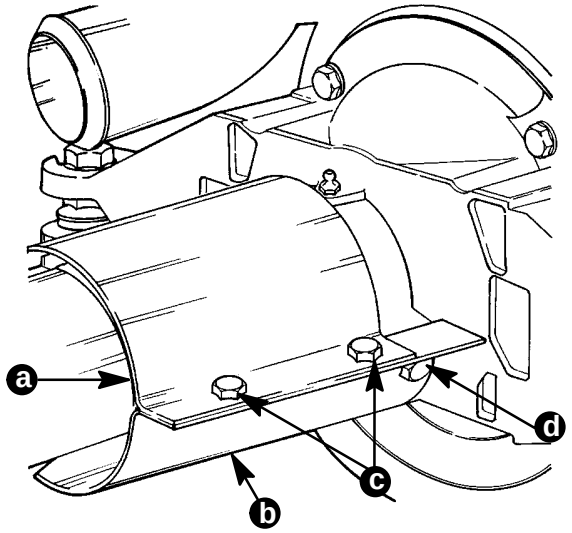
8. After engine has been aligned correctly, fasten front and rear engine mounts to stringers. Tighten mounting bolts securely.
9. Apply Loctite 271 to threads of bottom drive shaft shield retaining screws and install bottom shield on engine end as shown. Torque screws to 30 lb. ft. (41 N·m). Then install top shield as shown. Torque screws and nuts to 30 lb. ft. (41 N·m).



72028

a - Shaft Housing
b - Bottom Shield
c - Screws (3 Used - Two Hidden in This View) (Use Loctite 271)

Engine End Shown



72033

a - Top Shield
b - Bottom Shield
c - 4 Screws/Nuts (2 Hidden)
d - 3 Screws (2 Hidden)

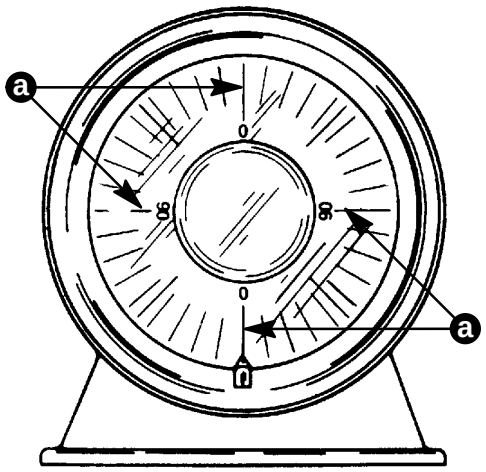
Engine End Shown

10. Proceed to “Engine Connections” section instructions following.

ENGINE MOUNT ADJUSTMENT WAS DISTURBED DURING SERVICE

NOTE: *A Universal Protractor is recommended for measuring the angles in the following steps.*

IMPORTANT: In the following steps, the protractor readings will be taken off of vertical and horizontal surfaces; therefore, both the 0 degree and the 90 degree marks will be used. It should be kept in mind that these are reference marks only and the assigned numbers should be ignored. It is only necessary to determine the number of degrees and to which side (left or right) of the reference marks the indicator needle rests. PROTRACTOR MUST BE VIEWED FROM THE SAME SIDE OF POWER PACKAGE THROUGHOUT INSTALLATION.



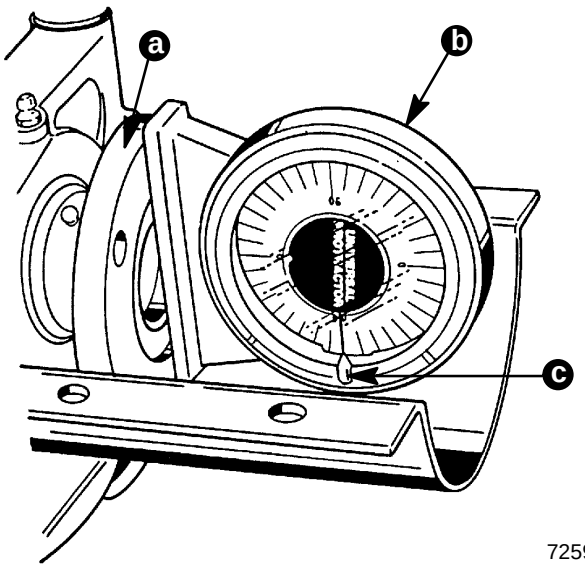
72429

a - Reference Marks

1. Refer to Section 8E - “Drive Shaft Models/Propeller Shaft,” and remove drive shaft.
2. Position base of protractor against input shaft flange, as shown. NOTE and RECORD the number of degrees and to which side of the reference mark the indicator needle has moved in the following chart.

Reading from Step 1. _____ degrees to the _____ side of reference mark.

IMPORTANT: Be sure that boat does not move once reading has been taken from input shaft flange, as this reading establishes a reference point for aligning drive shaft and engine following. If boat is moved, reference point may be altered and subsequently, improper drive shaft and engine alignment may occur. Alignment tool MUST BE in place during entire alignment procedure if drive unit is not installed.



72592

a - Indicator Shaft Flange
b - Protractor
c - Indicator Needle

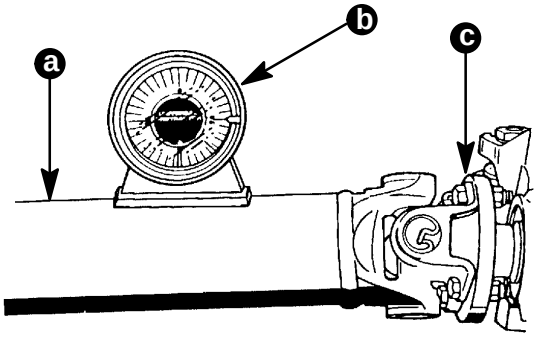
NOTE: *For ease of installation we recommend the use of a chain leveler in the following steps.*

3. Adjust engine mounts so that an equal amount of up and down adjustment exists.
4. Attach a suitable lifting chain to lifting eyes on engine and adjust so that engine will be level when suspended, then place engine into its approximate position (in boat) using an overhead hoist.
5. Refer to Section 8E - “Drive Shaft Models/Propeller Shaft,” and install drive shaft while observing precautions in Section 8D, especially about aligning gimbal bearing U-joint centerlines with extension drive shaft U-joint centerlines at bearing support input shaft. DO NOT install shields at this time.

⚠CAUTION

Engine MUST BE aligned correctly to achieve proper engine operation and to prevent damage to drive shaft. If drive shaft is run at an incorrect angle, damage to universal joint bearings may result.

6. Position base of protractor on drive shaft; then raise or lower engine (as boat construction permits) until indicator needle is 1 degree to 3 degrees on either side of reading taken in Step 1. Record this reading in the following chart for later use.



70238

a - Drive Shaft
b - Protractor
c - Output Shaft Flange

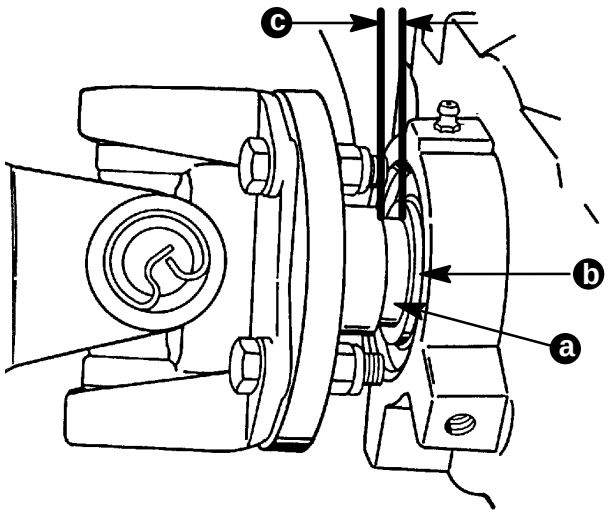
Reading from Step 6. _____ degrees to the _____ side of reference mark.

7. Adjust stringer height so that the stringers just contact the engine mount bases.

⚠CAUTION

Failure to properly position output shaft flange (as described following) may result in bearing damage.

8. Relieve hoist tension from engine, then slide engine fore or aft as needed to obtain 1/4 in. (6.4 mm) between flange shoulder and extension shaft housing bearing, as shown.

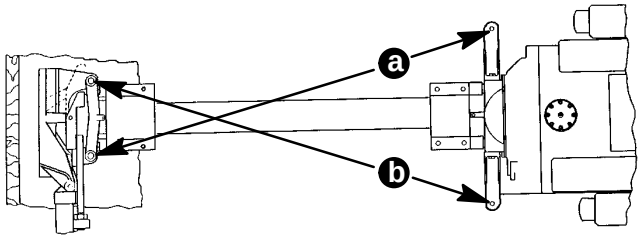


72591

a - Flange Shoulder
b - Bearing
c - 1/4 In. (6 mm)

9. Position engine for correct engine and drive shaft lateral alignment as follows:

   a. Measure the length of (a) and (b) to the centers of bolt holes. They MUST BE EQUAL. If they are not equal, slide the aft and forward ends of the engine equal amounts in opposite directions to obtain equal lengths for (a) and (b).

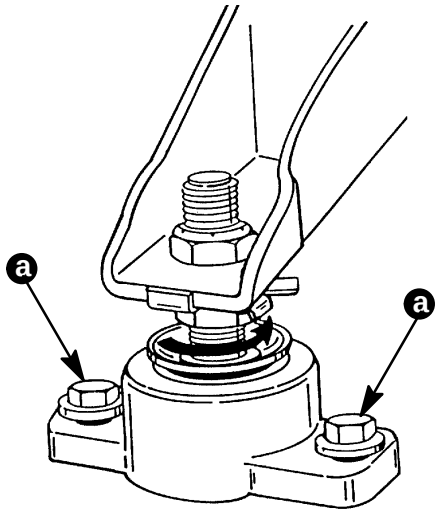


70246

These Dimensions Must Be Equal

   b. Recheck Step 8. If Step 8 is not as specified, adjust and recheck Step 9a. Continue this process until both Steps 8 and 9a are as specified.

10. After engine has been aligned correctly, fasten front and rear engine mounts to stringers. Tighten securely.

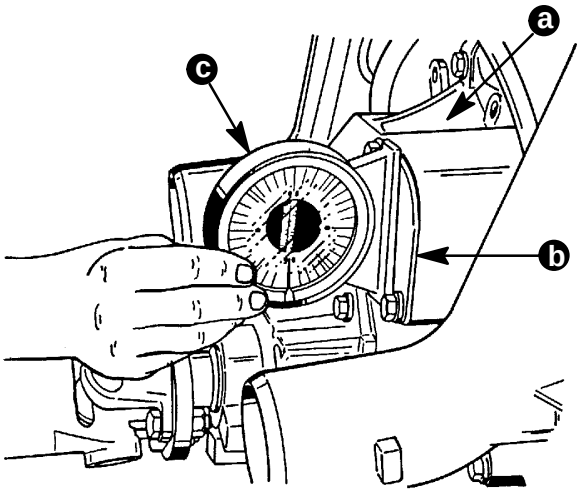


72922

Typical Mounting Shown

a - Mounting Bolts

11. Position protractor on starter housing cover plate, as shown. Now, raise or lower front engine mount adjusting nuts as required so that protractor needle reads exactly the same number of degrees as that recorded in Step 1.

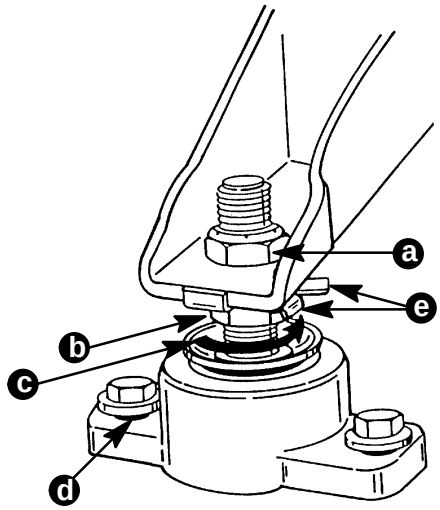


72593

Thru-Prop Exhaust Shown

a - Flywheel Housing
b - Starter Housing Cover Plate
c - Protractor

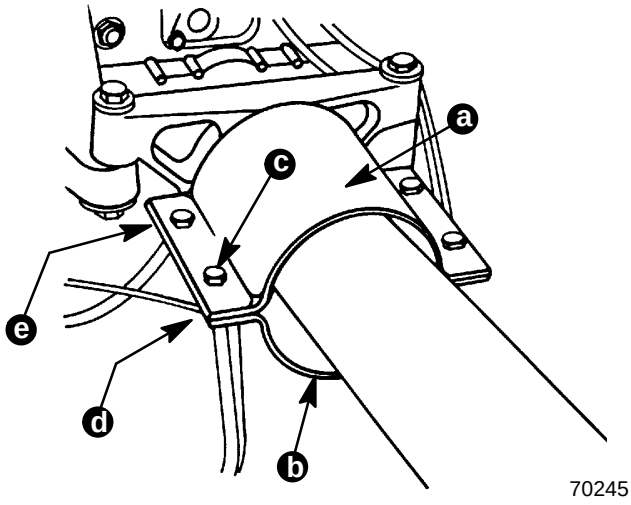
12. Position protractor on drive shaft and recheck angle. Angle should be the same as that recorded in Step 6. If not, raise or lower all four engine mount adjustment nuts an equal amount until correct angle is reached.
13. Tighten ALL engine mount nuts securely. Bend washer tab down on each adjustment nut.



72922

a - Locknut
b - Adjustment Nut
c - Turn Nut In This Direction (Counterclockwise) To Raise Front Of Engine
d - Slotted Hole Toward Front Of Engine
e - Tab Washer

14. Apply Loctite 271 to threads of bottom drive shaft shield retaining screws and install bottom shields on engine and transom end as shown. Torque screws to 30 lb. ft. (41 N·m). Then install both top shields as shown. Torque screws and nuts to 30 lb. ft. (41 N·m).



70245

Top Shield and Bottom Shield at Transom End (Engine End Similar)

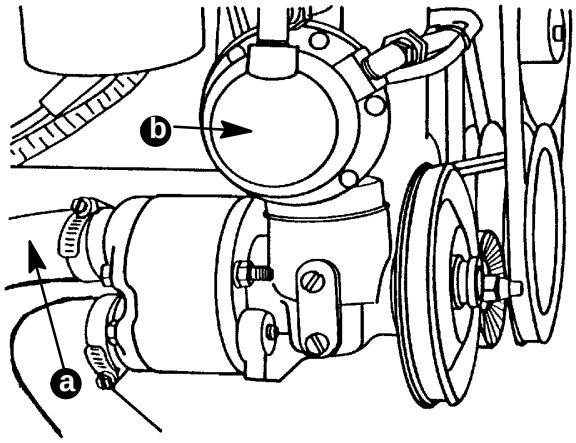
a - Top Shield
b - Bottom Shield
c - Bolt 3/8-16 x 7/8 In. (22.2 mm)
d - Nut 3/8-16
e - Screws (Use Loctite 271)

15. Proceed to “Engine Connections” section instructions following.

Engine Connections

IMPORTANT: When routing all wire harnesses and hoses, be sure they are routed and secured to avoid coming in contact with hot spots on engine and avoid contact with moving parts.

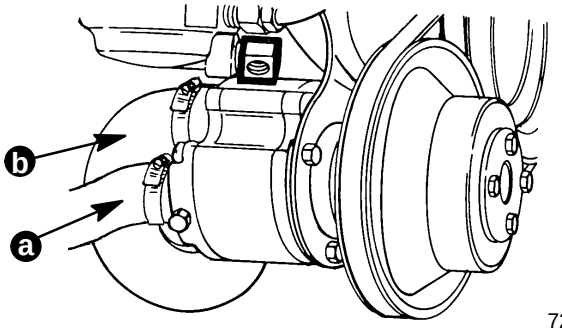
1. Connect seawater inlet hose to seawater pump as shown. Tighten hose clamp securely.



70346

Engines With Mechanical Fuel Pump / Seawater Pump

a - Seawater Inlet Hose Connection
b - Mechanical Fuel Pump

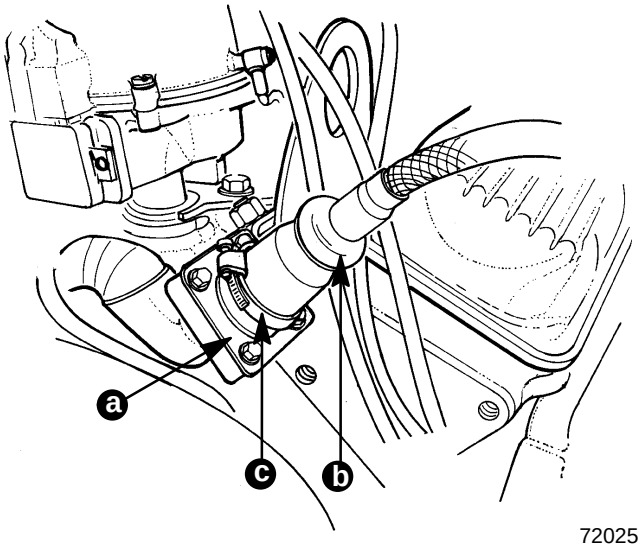


72352

Engines Without Mechanical Fuel Pump

a - Seawater Inlet Hose
b - Hose To Cooler

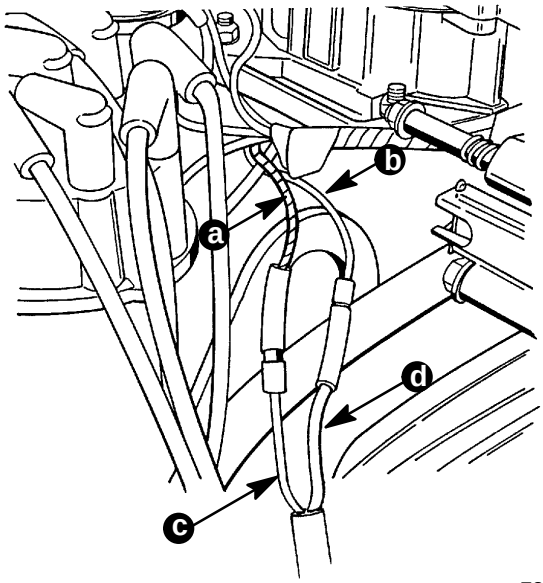
2. Connect instrument harness to engine harness with hose clamp. Tighten clamp securely.



72025

a - Engine Wiring Harness
b - Instrumentation Wiring Harness Plug
c - Hose Clamp - Tighten Securely

3. Connect two trim position sender leads from gimbal housing to leads from engine harness.



72582

a - BROWN / WHITE (From Engine Harness)
b - BLACK (From Engine Harness)
c - BLACK (From Transom Assembly)
d - BLACK (From Transom Assembly)

⚠WARNING

Be careful when working on fuel system. Gasoline is extremely flammable and highly explosive under certain conditions. Do not smoke or allow spark or open flame in area. Wipe up any spilled fuel immediately.

FUEL SUPPLY CONNECTIONS

⚠WARNING

Avoid gasoline fire or explosion. Improper installation of brass fittings or plugs into fuel pump or fuel filter base can crack casting and/or cause a fuel leak.

- **Apply #592 Loctite Pipe Sealant with Teflon to threads of brass fitting or plug. DO NOT USE TEFLON TAPE.**
- **Thread brass fitting or plug into fuel pump or fuel filter base until finger tight.**
- **Tighten fitting or plug an additional 1-3/4 to 2-1/4 turns using a wrench. DO NOT OVER-TIGHTEN.**
- **Install fuel line. To prevent over-tightening, hold brass fitting with suitable wrench and tighten fuel line connectors securely.**
- **Check for fuel leaks.**

4. Connect fuel line from fuel tank(s) to engine. Make certain connections are secure. Check for leaks.

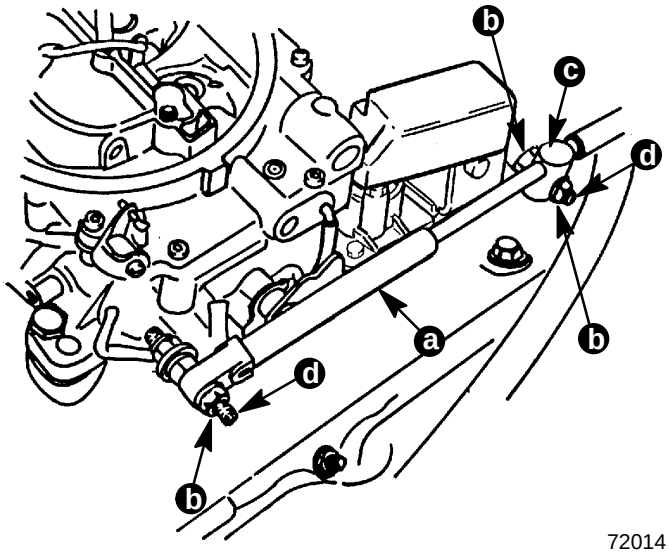
Throttle Connections

WEBER 4 BARREL CARBURETOR

1. Place remote control handle(s) in neutral, idle position.

IMPORTANT: Be sure that cable is routed in such a way as to avoid sharp bends and/or contact with moving parts. DO NOT fasten any items to throttle cable. Outer cable must be free to move when cable is actuated.

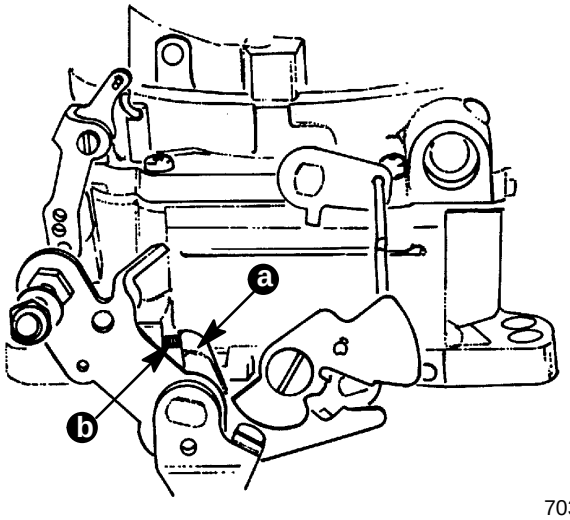
2. Install cable end guide on throttle lever, then push cable barrel lightly toward throttle lever end. (This will place a slight preload on cable to avoid slack in cable when moving remote control lever.) Adjust barrel on throttle cable to align with anchor stud.
3. Secure throttle cable with hardware (retained) as shown. Tighten cable end guide nut until it bottoms out and then back off one full turn. Tighten cable barrel securely. DO NOT OVER-TIGHTEN, as cable must pivot freely.



72014

a - Cable End Guide
b - Attaching Hardware (DO NOT Over-Tighten)
c - Cable Barrel
d - Anchor Studs

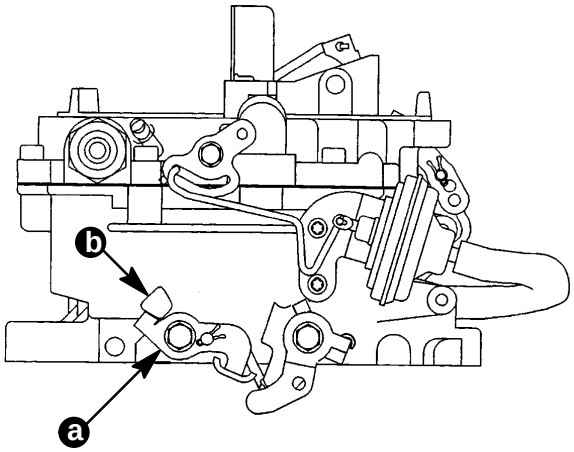
4. Place remote control throttle lever in the wide-open-throttle (W.O.T.) position. Check to ensure that throttle shutters (valves) are completely open and throttle shaft lever contacts carburetor body casting.
5. Return remote control throttle lever to idle position and check to ensure that throttle lever contacts idle speed adjustment screw.



70392

Idle Position

a - Throttle Lever Contacts (b) In idle Position
b - Idle Speed Adjustment Screw



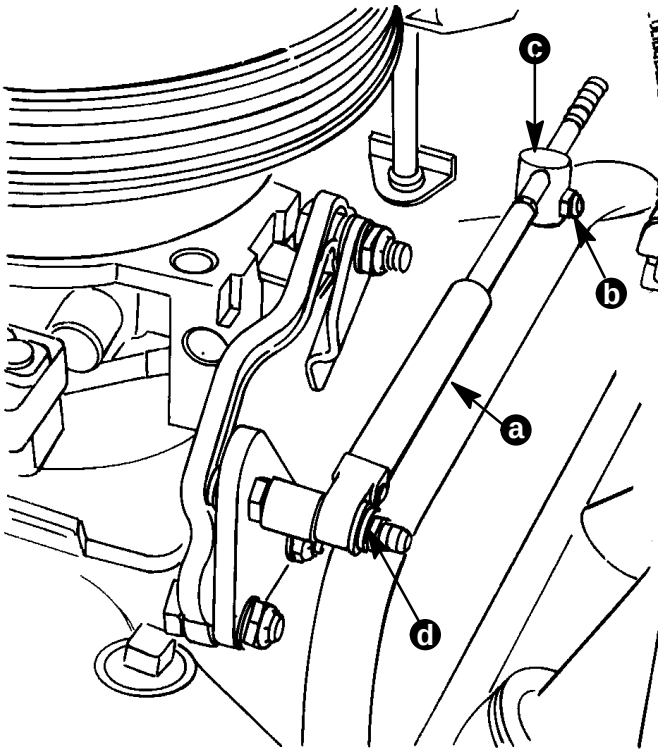
71159

Wide-Open-Throttle Position

a - Throttle Shaft Lever Contacts (b) At W.O.T. Position
b - Carburetor Body Casting

THROTTLE BODY INJECTION

1. Install cable end guide on throttle lever, then push cable barrel end lightly toward throttle lever end. (This will place a slight preload on shift cable to avoid slack in cable when moving remote control lever). Adjust barrel on throttle cable to align with hole in anchor plate.
2. Secure throttle cable with hardware as shown and tighten securely.
3. Place remote control throttle level in the wide open throttle (W.O.T.) position. Check to ensure that throttle plates are completely open.
4. Return remote control throttle lever to idle position.



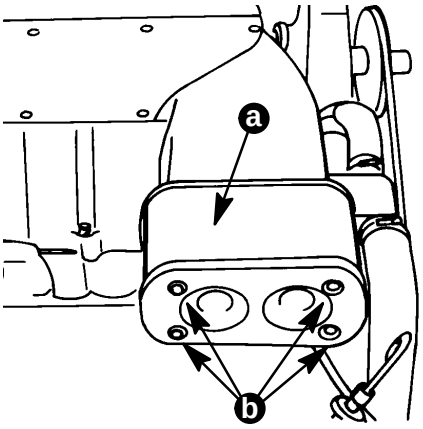
a - Cable End Guide
b - Flat Washer and Locknut - Tighten Until Bottoms Out, Then Back Off One Half Turn
c - Cable Barrel
d - Flat Washer and Locknut

MULTI-PORT INJECTION

1. Place remote control handle(s) in neutral idle position.

IMPORTANT: Be sure that cable is routed in such a way to avoid sharp bends and/or contact with moving parts. DO NOT fasten any items to throttle cable. Outer cable must be free to move when cable is actuated.

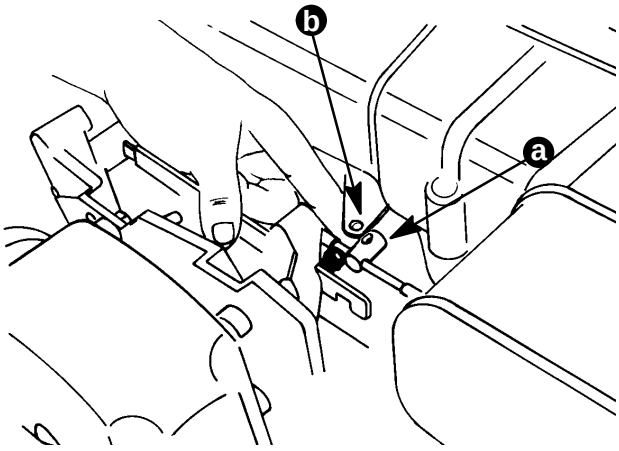
2. Remove flame arrestor.



71481

a - Flame Arrestor (Earlier Style)
b - Locknuts

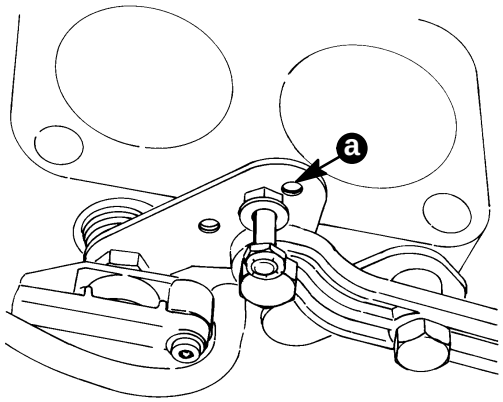
3. Install cable end guide on throttle lever, then push cable barrel end lightly toward throttle lever end. (This will place a slight preload on shift cable to avoid slack in cable when moving remote control lever). Adjust barrel on throttle cable to align with hole in anchor plate. Ensure hole in barrel positions cable as shown.



71711

a - Cable Barrel
b - Anchor Plate

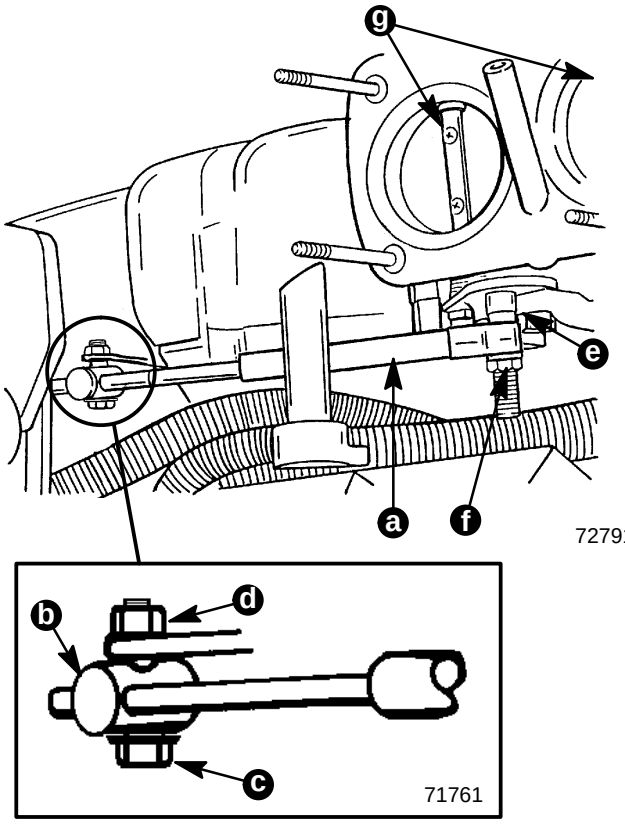
NOTE: *If Boat is equipped with Quicksilver Zero Effort Controls, the throttle cable mounting stud must be most forward position on throttle lever.*



73855

a - Position For Zero Effort Controls

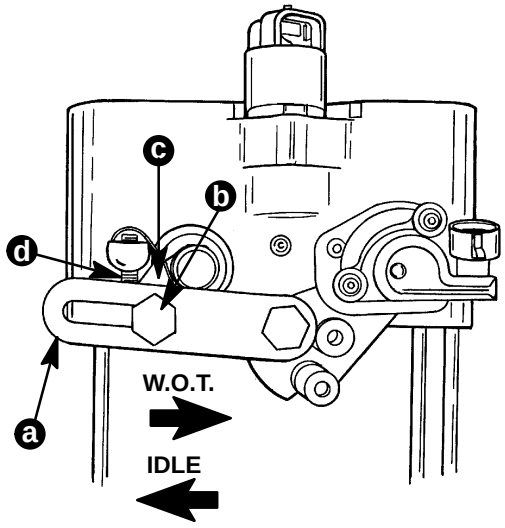
4. Secure throttle cable with hardware as shown and tighten securely.
5. Place remote control throttle level in the wide open throttle (W.O.T.) position. Check to ensure that throttle plates are completely open.
6. Return remote control throttle lever to idle position and check to ensure that throttle plates are completely closed.



72791

71761

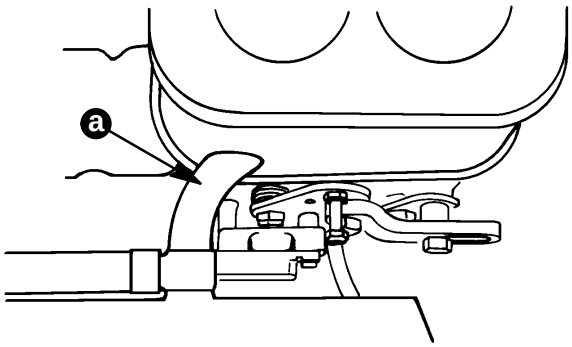
a - Cable End Guide
b - Cable Barrel
c - Bolt
d - Locknut
e - Throttle Lever
f - Flat Washer and Lockwasher
g - Throttle Plates



72794

a - Throttle Lever
b - Positive Stop Screw
c - Throttle Stop Lever
d - Throttle Stop Screw

7. Reinstall flame arrestor and tighten locknuts securely. Position crankcase vent hose against flame arrestor as shown.

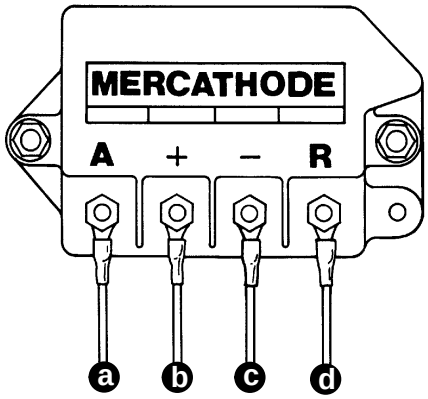


71764

a - Crankcase Vent Hose

IMPORTANT: Do not attach any accessory ground (–) wires to transom plate ground point. Accessory ground wires should only be attached to ground stud on engine.

8. Connect any grounding wires or accessories that may have been disconnected.
9. **Models with MerCathode:** Connect wires to MerCathode controller assembly as shown. Apply a thin coat of Quicksilver Liquid Neoprene to all connections.



22232

a - ORANGE Wire - From Electrode On Transom Assembly
b - RED/PURPLE Wire - Connect (Other End) to Positive (+) Battery Terminal
c - BLACK Wire - From Engine Harness
d - BROWN Wire - From Electrode on Transom Assembly

IMPORTANT: Adjust shift cables as outlined in appropriate Stern Drive Service Manual.

10. Refer to appropriate Stern Drive Service Manual and install and adjust drive unit and remote control shift cables, using hardware retained.

IMPORTANT: After fluid hose installation in the following, bleed power steering system as outlined in SECTION 1B - "Maintenance" of this manual, or refer to the appropriate Stern Drive Service Manual.

⚠CAUTION

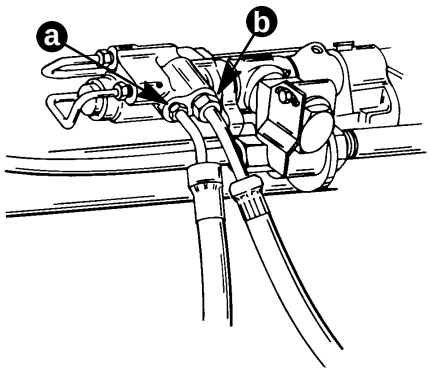
Route hoses exactly as shown below. This will help avoid stress on the hose fittings and will help avoid kinks in the hose.

IMPORTANT: Make hydraulic connections as quickly as possible to prevent fluid leakage.

IMPORTANT: Be careful not to cross-thread or over-tighten fittings.

11. Connect both hydraulic hose fittings.

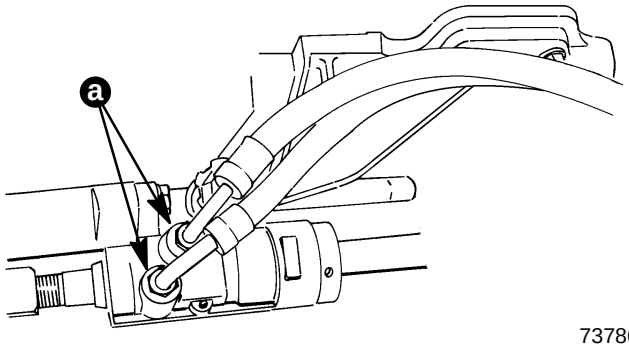
    a. **Early Style Control Valves:** Torque the large fitting to 23 lb. ft. (31 N·m). Torque the small fitting to 100 lb. in. (11 N·m).



22023

a - Small Fitting
b - Large Fitting

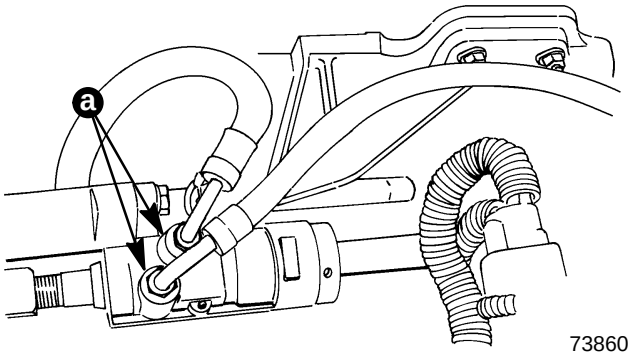
    b. **Later Style Control Valve:** Torque both fittings to 23 lb. ft. (31 N·m). Route hoses as shown for each model



73786

All Models Except 502 Multi-Port Injection

a - Hose Fittings



73860

502 Multi-Port Injection with Oil Cooler Return Lines on the Starboard Side of the Cooler

a - Hose Fittings

12. Connect battery cables to battery by FIRST connecting positive (+) battery cable (usually RED) to positive (+) battery terminal. Tighten clamp securely. Then, connect negative (–) battery cable (usually BLACK) to negative (–) battery terminal. Tighten clamp securely.

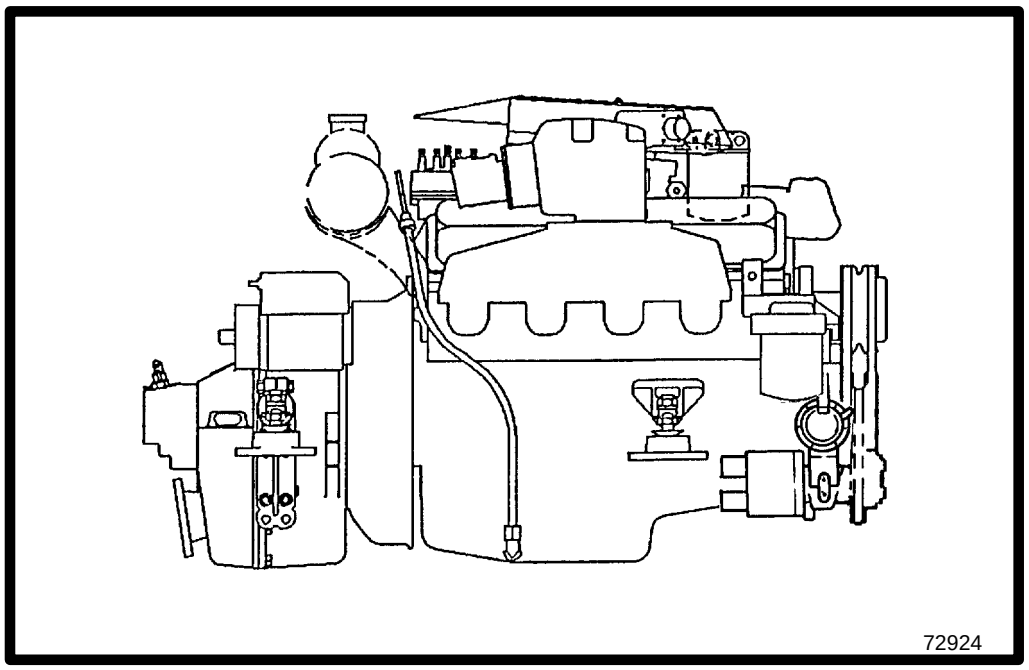
NOTE: *Spray terminals with a battery connection sealant to help retard corrosion.*

THIS PAGE IS INTENTIONALLY BLANK TO ALLOW FOR CORRECTIONS OR ADDITIONS AT A LATER DATE

REMOVAL AND INSTALLATION

2

C



MIE - VELVET DRIVE TRANSMISSIONS

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Torque Specifications

Fastener Location		Lb. Ft.	N·m
Battery Cables		Securely	
Engine Mount Pads			
Hose Clamps			
Mount Locking Nut			
Propeller Shaft Coupler To Transmission Output Flange		50	68
Trunnion Clamping Screw / Nut			
Remote Control Shift Cable	Cable Barrel	Securely	
	Cable End Guide	NOTE 1	
Remote Control Throttle Cable	Cable Barrel	Securely	
	Cable End Guide	NOTE 1	

NOTE 1: Tighten, then back nut off one half turn.

NOTE 2: Bend tab against adjusting nut.

Lubricants / Sealants

Description	Part Number
Quicksilver 2-4-C Marine Lubricant With Teflon	92-825407A3
Quicksilver Liquid Neoprene	92-25711--2

Removal

Engine Removal

1. Disconnect battery cables from battery.
2. Remove instrument panel harness connector plug from engine harness receptacle after loosening clamp.

⚠WARNING

Be careful when working on fuel system. Gasoline is extremely flammable and highly explosive under certain conditions. Do not smoke or allow spark or open flame in area. Wipe up any spilled fuel immediately.

3. Using wrench to stabilize brass coupling at fuel inlet, loosen fuel line fitting, disconnect and suitably plug fuel line to prevent fuel in tank from leaking into bilge.
4. Disconnect throttle cable from carburetor and retain locknuts and hardware.
5. Disconnect shift cable from transmission.
6. Disconnect seawater inlet hose from engine.
7. Disconnect exhaust system hoses.
8. Disconnect any grounding wires and accessories that are connected to engine.
9. Disconnect propeller shaft coupler from transmission output flange.

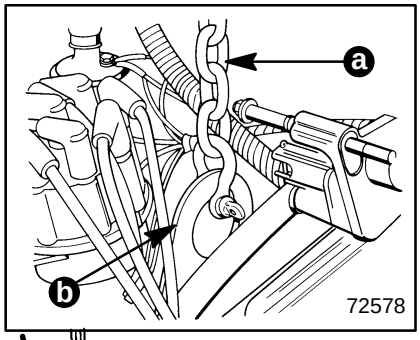
⚠CAUTION

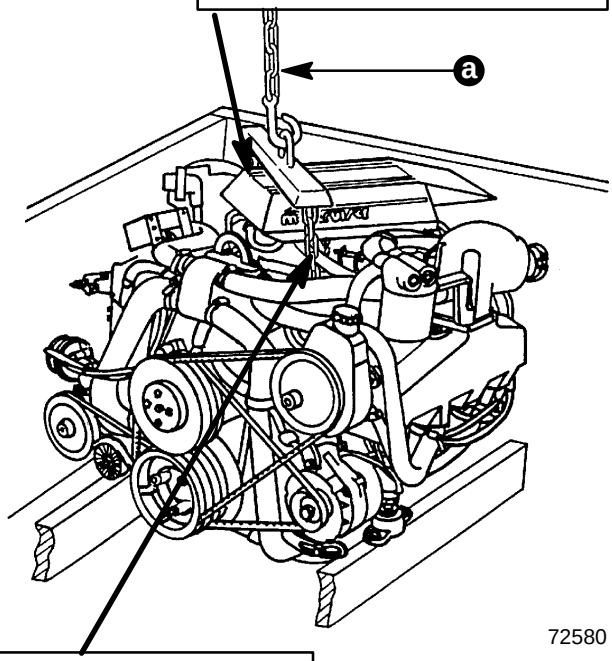
Center lifting eye (located on top of thermostat housing) is used for engine alignment only. DO NOT use to lift entire engine.

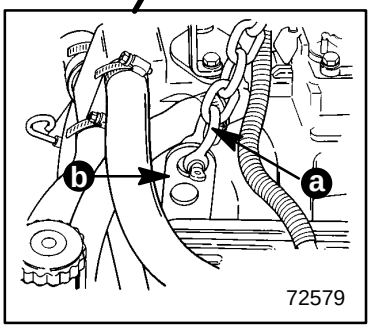
⚠CAUTION

DO NOT allow lifting sling to hook or compress engine components or damage to them will occur.

10. Support engine with suitable sling through lifting eyes on engine.

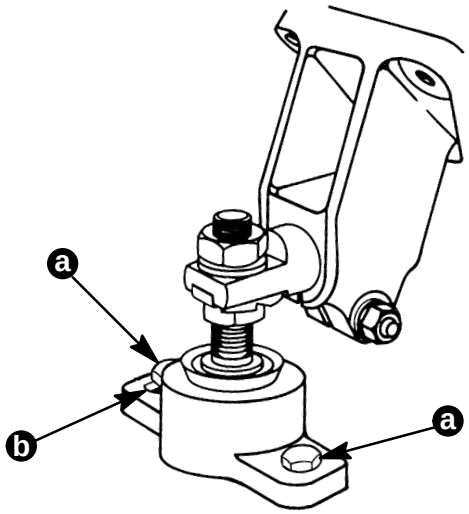






a - Suitable Sling
b - Engine Lifting Eyes

11. Remove front and rear engine mounting bolts. Retain hardware.



72638

All Engines

a - Bolts Or Lag Screws (With Washers)
b - Slot Forward (If So Designed)

12. Carefully remove engine.

Installation

Engine Installation and Initial Alignment

1. Follow instructions “a” or “b”:

   a. **Engine mount(s) or adjustment <u>WAS NOT DISTURBED</u> during engine service:** <u>Proceed to following Step 2.</u>

   b. **Engine mount(s) or adjustment <u>WAS DISTURBED</u> during engine service:**

IMPORTANT: Engine mounts must be adjusted, as explained in the following, to center mount adjustment and establish a uniform height on all mounts.

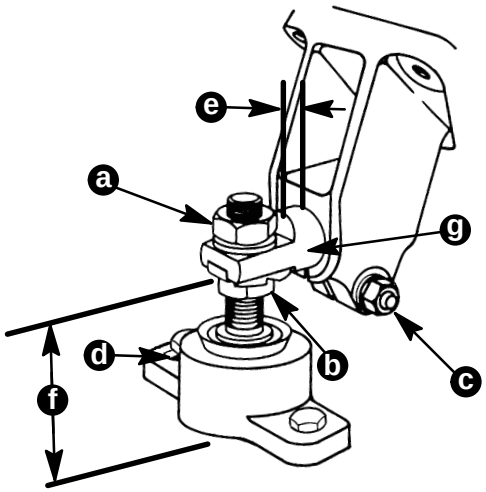
Ensure that all mounts are:

(1) In the center of their up-and-down adjustment.

(2) Mounting hole, which is a slot, is forward.

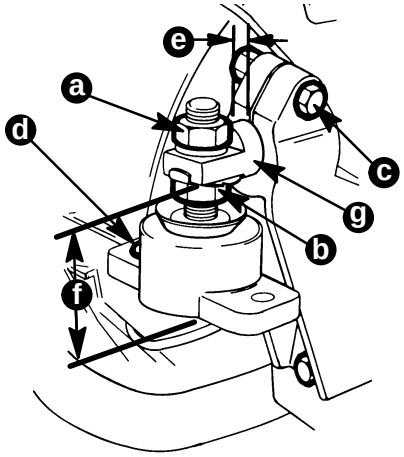
(3) Large diameter of mount trunnion extended as shown.

(4) Each mount base is downward. Tighten clamping screws and nuts slightly to prevent moving in or out. Mounts must be free to pivot when installing engine.



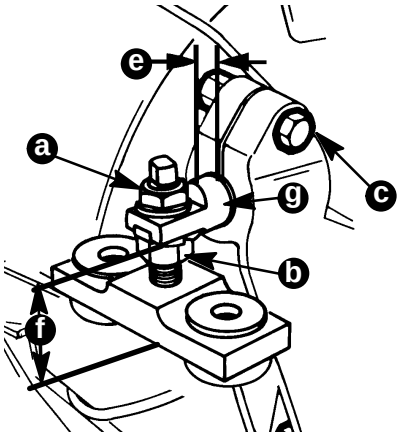
72638

All Engines



72594

Rear Mount - Typical



71182

Rear Mount - Typical

a - Locking Nut
b - Adjusting Nut
c - Trunnion Clamp Screw and Nut, With Lockwasher
d - Slot Forward
e - 3/8 In. ± 1/16 In. (10 mm ± 2 mm)
f - 2-5/8 In. ± 1/16 In. (67 mm ± 2 mm)
g - Mount Trunnion

Index

⚠CAUTION

Center lifting eye (located on top of thermostat housing) is used for engine alignment only. DO NOT use to lift entire engine.

⚠CAUTION

DO NOT allow lifting sling to hook or compress engine components or damage to them will occur.

2. Attach a suitable sling to lifting eyes on engine. **Refer to "Removal" section for location of lifting eyes.**

IMPORTANT: Engine bed must position engine so that a minimum of 1/4 in. (6 mm) up-and-down adjustment still exists on all four mounts after performing final alignment. This is necessary to allow for final engine alignment.

3. Lift engine into boat and position on engine bed so that transmission output flange and propeller shaft coupler are visibly aligned (no gap can be seen between coupling faces when butted together). **Adjust engine bed height,** if necessary, to obtain proper alignment. DO NOT use mount adjustments to adjust engine position at this time.
4. Check all four mounts to ensure that they are still positioned properly, then fasten mounts to engine bed with appropriate bolts or lag screws and hardware. Tighten lag bolts/screws securely.
5. Disconnect and remove sling. Proceed to "Engine Final Alignment" section following.

Engine Final Alignment

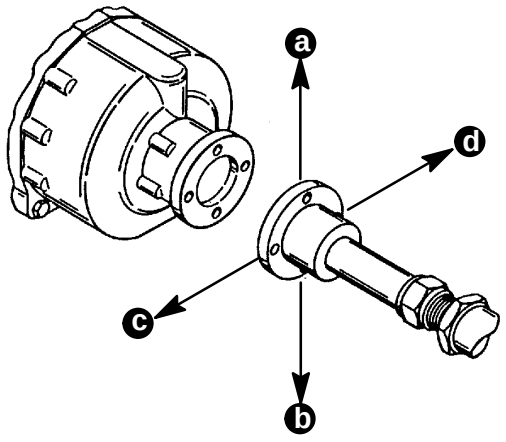
⚠CAUTION

To avoid vibration, noise and damage to transmission output shaft oil seal and bearings, engine must be properly aligned.

IMPORTANT: Engine alignment MUST BE RECHECKED with boat in the water, fuel tanks filled and with a normal load on board.

Engine must be aligned so that transmission output flange and propeller shaft coupler centerlines are aligned and coupling faces are parallel within .003 in. (0.07 mm). This applies to installations with solid couplings, as well as flexible couplings.

1. Check mating surfaces on transmission output flange and propeller shaft coupler faces to make sure they are clean and flat.
2. Center propeller shaft in shaft log as follows:
   a. Push down and then lift shaft as far as it will move. Then place shaft in the middle of the movement.
   b. Move shaft to port and then to starboard as far as shaft will move. Then place shaft in the middle of the movement.
   c. With shaft in center of shaft log, as determined by above procedures "a" and "b," align engine to shaft.

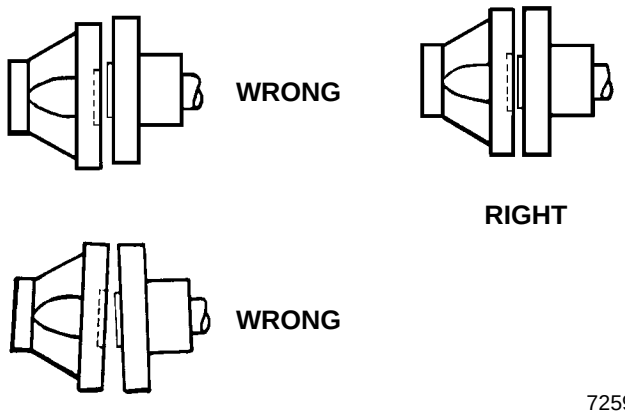


72595

a - Up
b - Down
c - Port
d - Starboard

3. Check that coupling centerlines align, by butting propeller shaft coupler against transmission output flange. Shoulder on propeller shaft coupler should engage recess on transmission output flange face with no resistance.

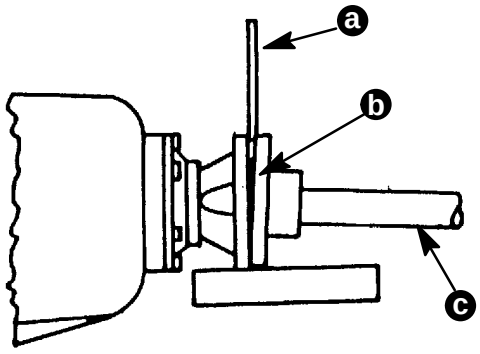
NOTE: *Some propeller shaft couplers may not have a shoulder on mating face. On these installations, use a straight edge to check centerline alignment.*



72597

IMPORTANT: Remote V-Drive Models: refer to remote V-drive manufacturer's instructions for drive shaft (between transmission and remote V-drive) alignment.

4. Check for angular misalignment, by hand holding coupling faces tightly together; check for a gap between faces with a .003 in. (0.07 mm) feeler gauge at 90° intervals.

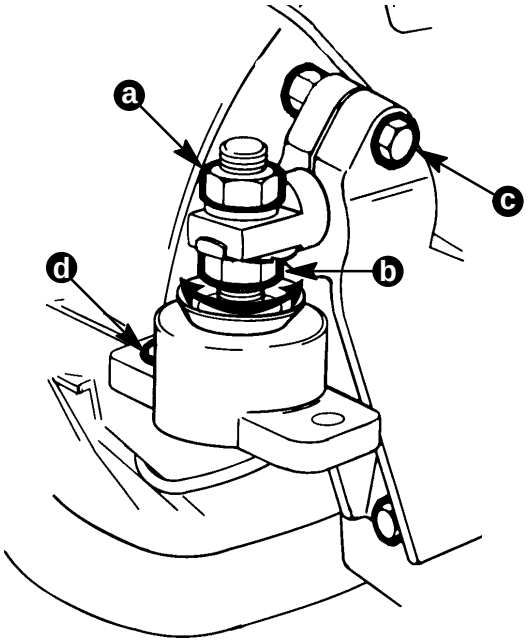


72598

a - Feeler Gauge
b - Transmission Coupling
c - Propeller Shaft
d - Straight Edge

5. If coupling centerlines are not aligned or if coupling faces are more than .003 in. (0.07 mm) out of parallel, adjust engine mounts as follows:
   a. TO ADJUST ENGINE UP OR DOWN: Loosen locking nut on mounts requiring adjustment and turn both front mount or rear mount adjusting nuts equally.

IMPORTANT: Both front mount (or rear mount) adjusting nuts must be turned equally to keep engine level from side to side.



72594

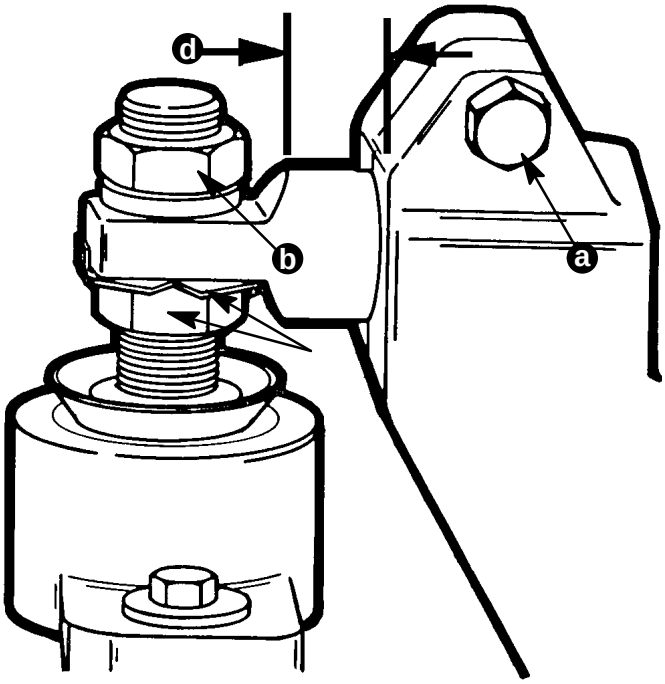
Typical Mount

a - Locking Nut
b - Adjusting Nut
c - Clamping Screws and Nuts, Wit Lockwashers (Two Each on Some Models)
d - Slot Forward (If So Designed - NOT Slotted On This Style Rear Mount)

b. TO MOVE ENGINE TO THE LEFT OR RIGHT: Loosen clamping screw and nut on all four mount brackets; move engine to the left or right as necessary to obtain proper alignment. On mounts which do have a slotted hole, a small amount of adjustment can be obtained with slot on front end of mounts. Loosen lag screws (which fasten mounts to engine bed) and move engine, as required. Tighten lag screws securely.

c. After engine has been properly aligned: Tighten engine mount nuts securely, and be certain to bend one of the tabs on the tab washer down onto flat of mount adjusting nut. Torque clamping screws and nuts to 50 lb. ft. (68 N·m).

IMPORTANT: Large diameter of mount trunnion MUST NOT extend over 3/4 in. (20 mm) from mount brackets on any of the mounts.



72599

a - Torque Clmaping Screw and Nut On All Four Mount Brackets To 50 Lb. Ft. (68 N·m)
b - Tighten Locking Nut On All Four Mounts Securely
c - Bend One Of The Tab Washer Down Onto Flat Of Adjusting Nut
d - Maximum Extension Of Large Diameter Of Trunnion - 3/4 In. (20 mm)

IMPORTANT: All coupler bolts must be SAE Grade 8 (Metric Grade 10.9) or better, with a shoulder (grip length) long enough to pass through the face mating plane of couplers.

6. Connect propeller shaft coupler to transmission output flange. Attach couplers together with bolts, lockwashers and nuts. Torque to 50 lb. ft. (68 N·m).

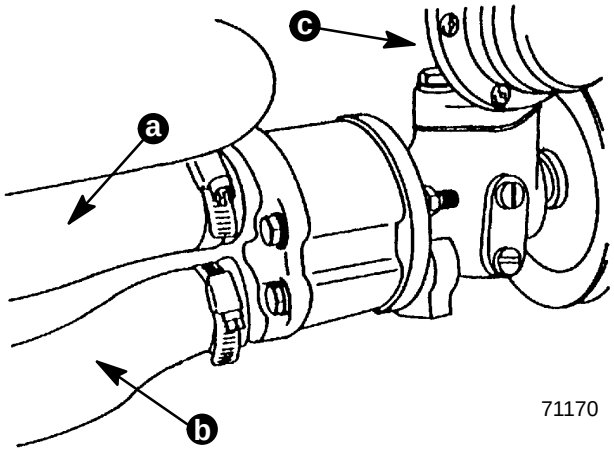
NOTE: *If propeller shaft coupler has setscrews, the shaft should be dimpled at setscrew locations. Setscrews should be safety wired after being tightened securely.*

Engine Connections

IMPORTANT: When routing all wire harnesses and hoses, be sure they are routed and secured to avoid coming in contact with hot spots on engine and avoid contact with moving parts.

1. Connect seawater inlet hose to seawater pump as shown. Tighten hose clamp securely.

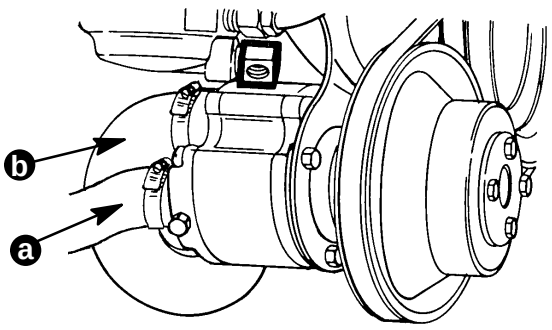
2. Connect water hoses to seawater pump.



71170

Engines With Combination Seawater / Fuel Pump

a - Seawater Inlet Hose
b - Hose To Cooler
c - Fuel Pump

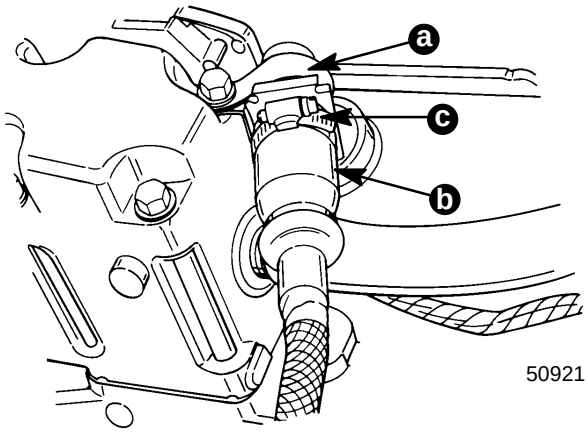


72352

Engines Without Mechanical Fuel Pump

a - Seawater Inlet Hose
b - Hose To Cooler

3. Connect instrument harness to engine harness with hose clamp. Tighten hose clamp securely.



50921

Harness Connection

a - Engine Wiring Harness Recptable Bracket
b - Instrument Wiring Harness Plug
c - Hose Clamp

FUEL SUPPLY CONNECTIONS

⚠ WARNING

Avoid gasoline fire or explosion. Improper installation of brass fittings or plugs into fuel pump or fuel filter base can crack casting and/or cause a fuel leak.

- **Apply #592 Loctite Pipe Sealant with Teflon to threads of brass fitting or plug. DO NOT USE TEFLON TAPE.**
- **Thread brass fitting or plug into fuel pump or fuel filter base until finger tight.**
- **Tighten fitting or plug an additional 1-3/4 to 2-1/4 turns using a wrench. DO NOT OVER-TIGHTEN.**
- **Install fuel line. To prevent over-tightening, hold brass fitting with suitable wrench and tighten fuel line connectors securely.**
- **Check for fuel leaks.**

⚠ WARNING

Be careful when working on fuel system. Gasoline is extremely flammable and highly explosive under certain conditions. Do not smoke or allow spark or open flame in area. Wipe up any spilled fuel immediately.

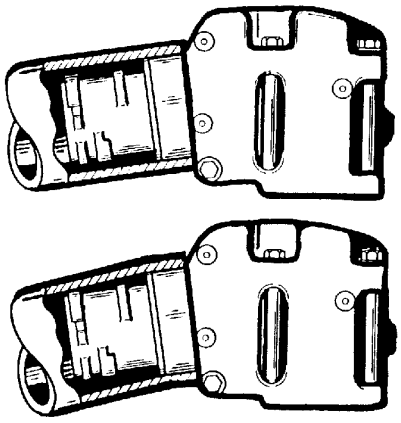
4. Connect fuel line from fuel tank(s) to engine. Make certain connection is secure. Check for leaks.
5. Connect exhaust system tubes and hoses using at least two hose clamps at each connection. Tighten hose clamps securely.

NOTICE

Exhaust hoses must be connected to exhaust elbows so that they do not restrict the flow of discharge water from exhaust elbow. If hoses are connected incorrectly, discharge water from exhaust elbow will not flow around entire inside diameter of hose. This will cause a hot spot in the hose which may eventually burn through.

CORRECT

INCORRECT



72538

NOTE: *Clamps not shown.*

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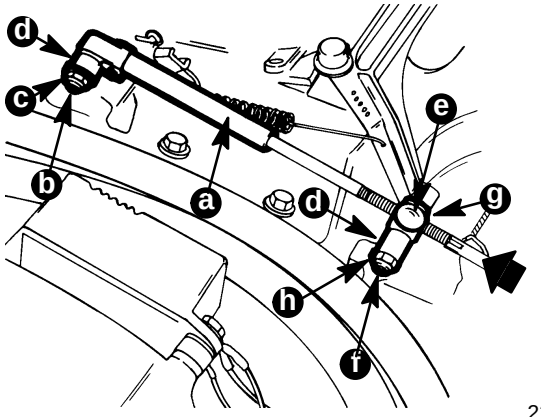
Throttle Cable Installation and Adjustment

Weber 4 Barrel Carburetor

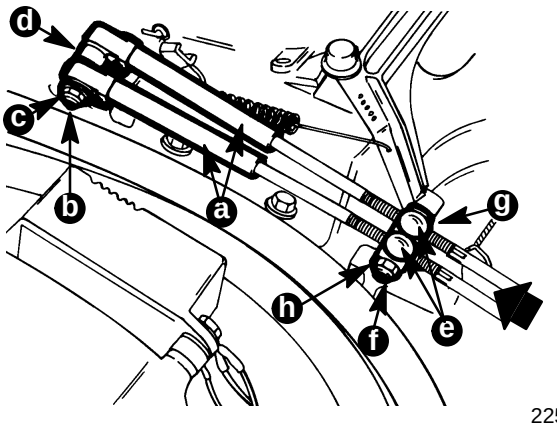
IMPORTANT: When installing throttle cable, be sure that cables are routed in such a way as to avoid sharp bends and/or contact with moving parts. DO NOT fasten any items to throttle cable.

1. Lubricate cable ends and barrels.
2. Place remote control throttle lever in idle position and attach cable end guide to carburetor throttle lever as shown.
3. Grasp cable behind barrel and push lightly as shown. Adjust cable barrel to align hole with anchor stud, then slide barrel onto stud.



22552

Single Station

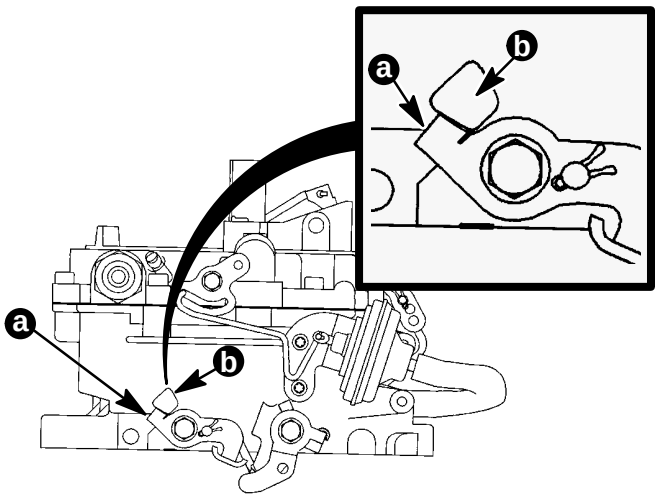


22553

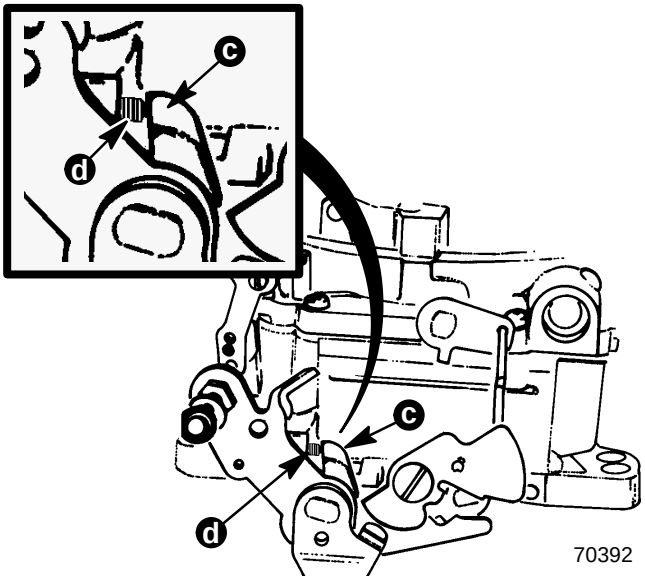
Dual Station

a - Throttle Lever Stud
b - Elastic Stop Nut and Washer
c - Spacer
d - Cable Barrel
e - Anchor Stud
f - Washer
g - Elastic Stop Nut
h - Cable End Guide

4. Secure throttle cable with hardware as shown and tighten securely. DO NOT OVERTIGHTEN, as cable must pivot freely.
5. Place remote control throttle lever in the wide open throttle (W.O.T.) position. Check to ensure that throttle plates are completely open.
6. Return remote control throttle lever to idle position and check to ensure that throttle lever contacts idle speed adjustment screw.



71159



70392

a - Throttle Shaft Lever [Contacts (b) at W.O.T. Position]
b - Carburetor Body Casting
c - Throttle Lever [Contacts (d) in Idle Position]
d - Idle Speed Adjustment Screw

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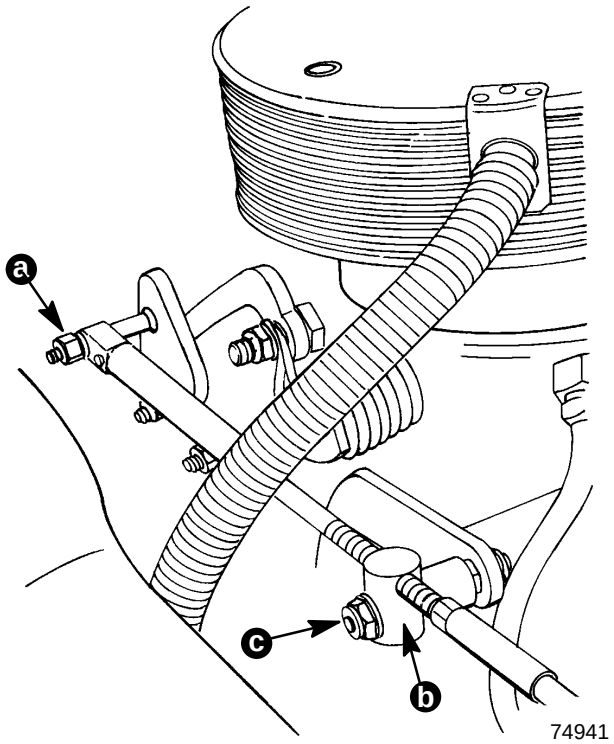
Throttle Body Injection

IMPORTANT: When installing throttle cable, be sure that cables are routed in such a way as to avoid sharp bends and/or contact with moving parts. DO NOT fasten any items to throttle cable.

1. Place remote throttle lever in idle position and attach cable to throttle body, following cable manufacturer's instructions.
2. Install cable end guide on throttle lever, then push cable barrel end lightly toward throttle lever end. (This will place a slight preload on shift cable to avoid slack in cable when moving remote control lever.) Adjust barrel on throttle cable to align with hole in anchor plate. Ensure hole in barrel positions cable as shown.



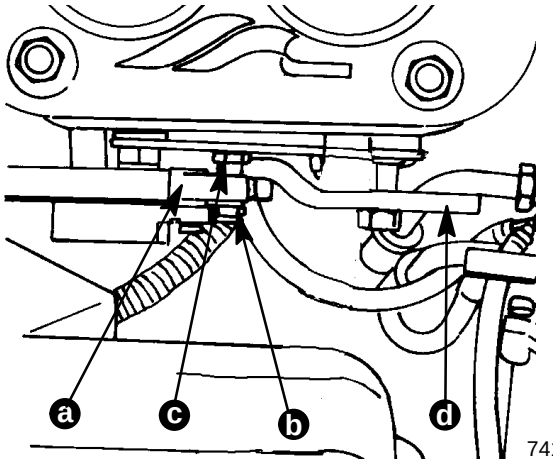
74941

a - Cable End
b - Cable Barrel
c - Locknut and Flat Washer - Tighten Until Nut Bottoms Out Then Back Off One-Half Turn

Multi-Port Injection

IMPORTANT: When installing throttle cable, be sure that cables are routed in such a way as to avoid sharp bends and/or contact with moving parts. DO NOT fasten any items to throttle cable.

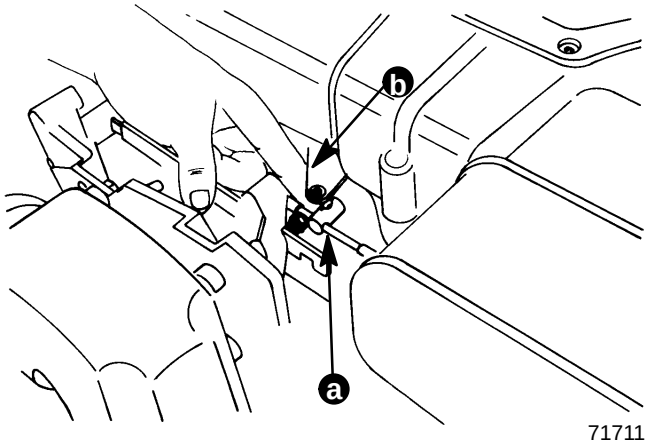
1. Lubricate cable ends and barrels.
2. Place remote throttle lever in idle position and attach cable to throttle body, following cable manufacturer's instructions.



74174

a - Cable End Guide
b - Throttle Lever Stud
c - Locknut and Flat Washer - Tighten Until Nut Bottoms Out Then Back Off One-Half Turn
d - Throttle Lever

3. Install cable end guide on throttle lever, then push cable barrel end lightly toward throttle lever end. (This will place a slight preload on shift cable to avoid slack in cable when moving remote control lever.) Adjust barrel on throttle cable to align with hole in anchor plate. Ensure hole in barrel positions cable as shown.



71711

a - Cable Barrel
b - Anchor Plate

Shift Cable Installation And Adjustment

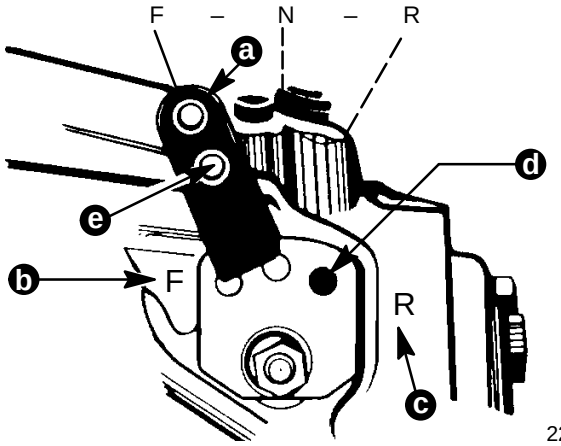
IMPORTANT: When installing shift cables, be sure that cables are routed in such a way as to avoid contact with moving parts and/or sharp bends [all bends must make greater than an 8 inch (203 mm) radius]. DO NOT fasten any items to shift cables.

Shift cable must be hooked up to remote control before starting installation and adjustment procedures. Refer to “Transmission - Propeller Rotation”, as previously outlined in the front of this manual, for transmission shift lever direction of movement versus propeller shaft output direction of rotation.

Velvet Drive Transmissions

IN-LINE AND REMOTE V-DRIVE

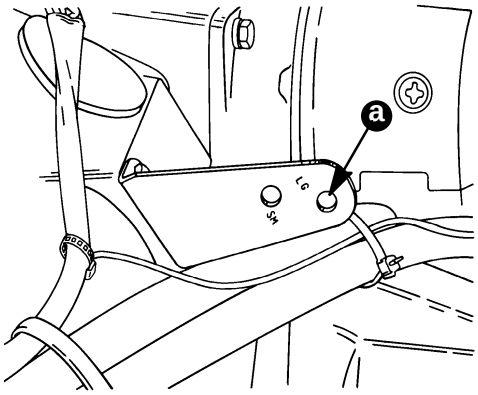
IMPORTANT: Velvet Drive Transmission Warranty is jeopardized if the shift lever poppet ball or spring is permanently removed, if the shift lever is repositioned or changed in any manner or if remote control and cable do not position shift lever correctly.



22457

a - Transmission Shift Lever
b - Shift Lever MUST BE Over This Letter When Propelling Boat FORWARD
c - Shift Lever MUST BE Over This Letter When Propelling Boat IN REVERSE
d - Poppet Ball MUST BE Centered in Detent Hole for Each F-N-R Position (Forward Gear Shown)
e - Install Shift Lever Stud in This Hole, If Necessary, To Center Poppet Ball in Forward and Reverse Detent Holes

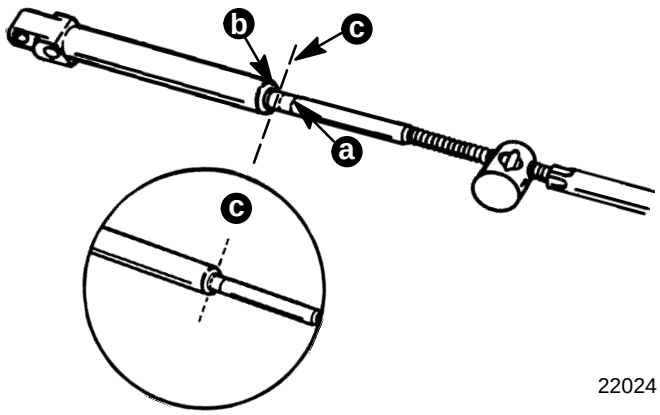
1. Verify shift cable stud is in appropriate stud hole as indicated. Tighten elastic stop nut securely.



50947

a - Anchor Stud Hole

2. Place remote control shift lever, and transmission shift lever in neutral position.
3. Remove nuts and washers from shift cable attaching studs.
4. Locate center of remote control and control shift cable play (backlash), as follows:
   a. Check that remote control is in neutral position.
   b. Push in on control cable end with enough pressure to remove play, and mark position “a” on tube.
   c. Pull out on control cable end with enough pressure to remove play, and mark position “b” on tube.
   d. Measure distance between marks “a” and “b,” and mark position “c,” half-way between marks “a” and “b.”



22024

5. Center cable-end play, then adjust cable barrel to align holes in barrel, and in cable end guide, with attaching points on transmission.
6. Temporarily install shift cable. Do not tighten at this time.

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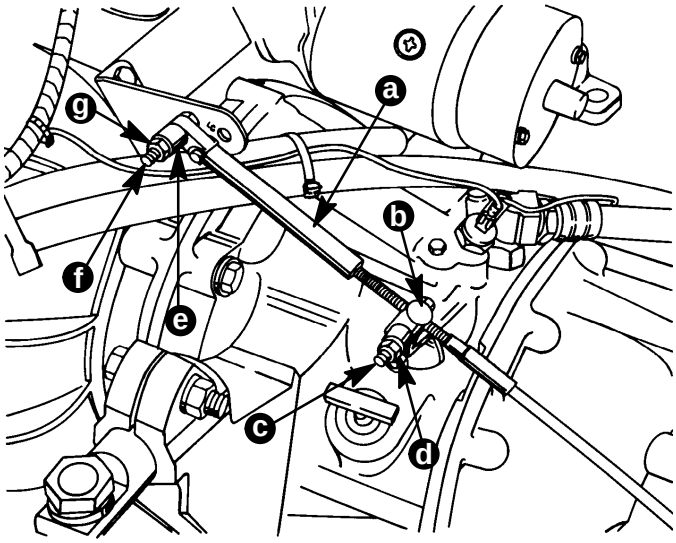
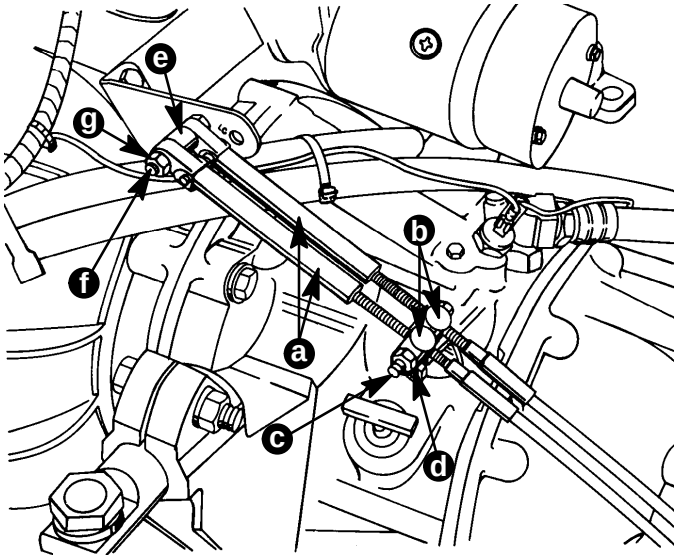
7. Place remote control shift lever in forward gear position and check position of transmission shift lever. Shift lever must be positioned as previously indicated.
8. Place remote control lever in reverse gear position and again check shift lever position. Lever must be positioned as previously indicated.
9. If transmission shift lever will position properly in one gear, but not in the other, recheck shift cable adjustment. If transmission shift lever will not position properly in both gears, move transmission shift lever stud (a), from top hole in shift lever, to bottom hole, and recheck for proper positioning. If proper positioning is still not obtained, remote control does not provide sufficient shift cable travel and must be replaced.
10. Reattach nut and washer to cable end guide stud. Tighten until snug, then back off one-half turn.
11. Reattach nut and washer to cable barrel stud. Tighten until they bottom out. Tighten securely, but do not overtighten.



50947

Rear Entry Single Station Installation In-Line And Remote V-Drive

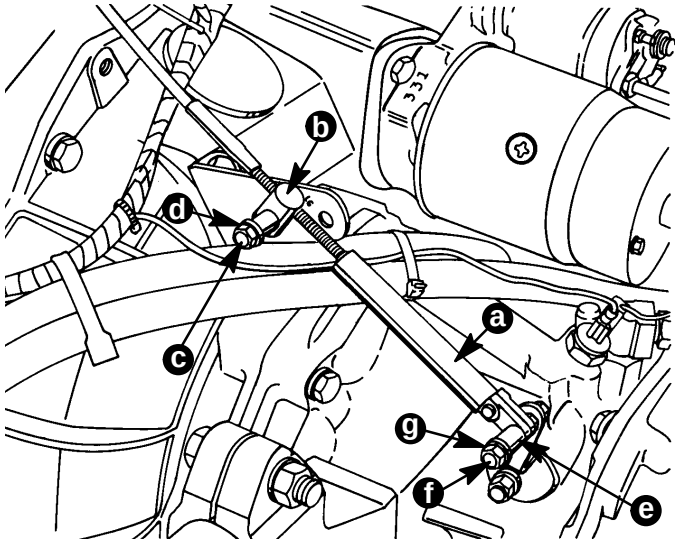
a - Cable End Guide
b - Cable Barrel
c - Cable Barrel Stud
d - Elastic Stop Nut and Washer
e - Spacer
f - Cable End Guide Stud
g - Elastic Stop Nut and Washer



50947

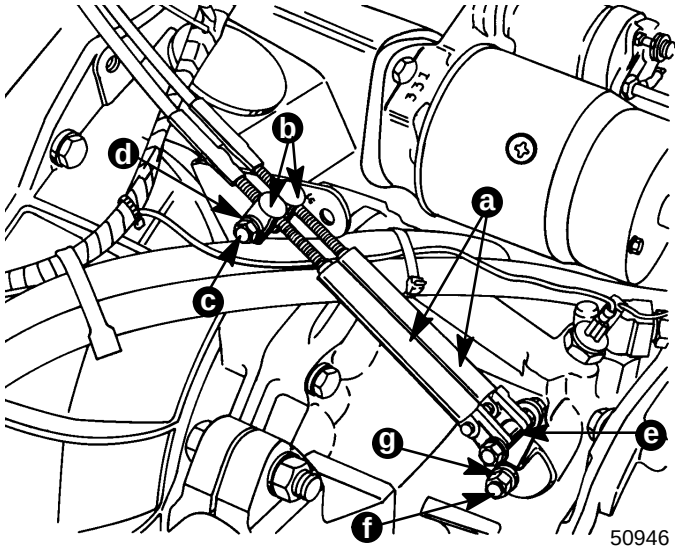
Rear Entry Dual Station Installation In-Line And V-Drive

a - Cable End Guide
b - Cable Barrel
c - Cable Barrel Stud
d - Elastic Stop Nut and Washer
e - Spacer
f - Cable End Guide Stud
g - Elastic Stop Nut and Washer



50946

Front Entry Single Station Installation In-Line And V-Drive

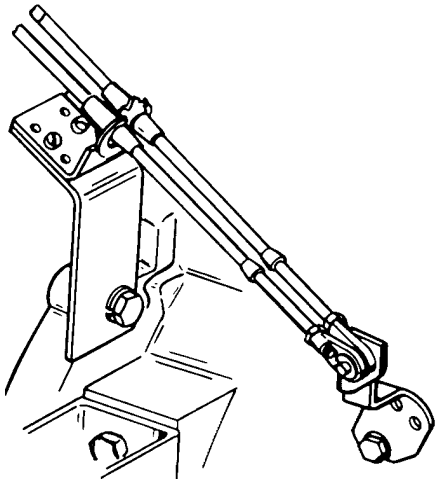


50946

Front Entry Dual Station Installation In-Line And V-Drive

a - Cable End Guide
b - Cable Barrel
c - Cable Barrel Stud
d - Elastic Stop Nut and Washer
e - Spacer
f - Cable End Guide Stud
g - Elastic Stop Nut and Washer

NOTE: *For models equipped with a dual station shift bracket such as the one shown, refer to shift cable manufacturer's instructions for adjusting the cable. Shift lever must be positioned as stated in the preceding steps.*



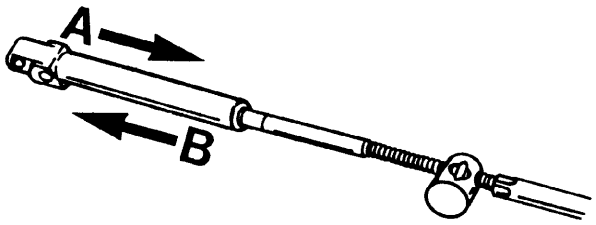
22457

Dual Station Shift Bracket (Not Quicksilver)

5000 SERIES (8° DOWN ANGLE AND V-DRIVE)

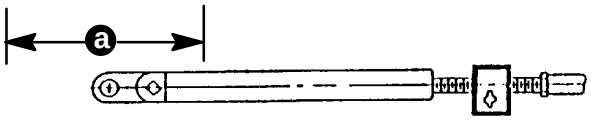
For Left-Hand Propeller Shaft Rotation: Shift cable hookup at remote control must result in shift cable end guide moving in direction “A” when remote control handle is placed in forward position.

For Right-Hand Propeller Shaft Rotation: Shift cable hookup at remote control must result in shift cable end guide moving in direction “B” when remote control handle is placed in forward position.



23242

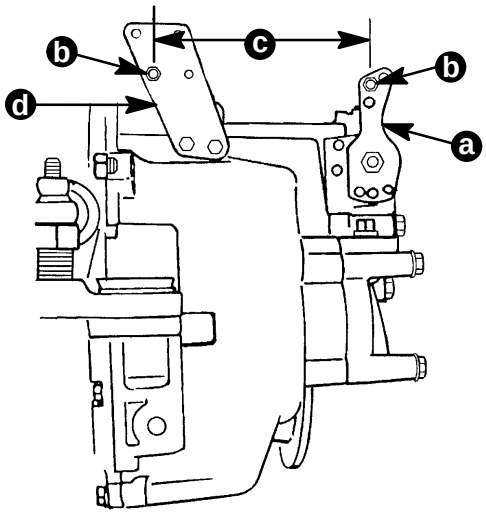
Remote control must provide a total shift cable travel (at transmission end) of at least 2-3/4 in. (70 mm). This is necessary to position transmission shift lever fully in the forward and reverse gear positions. Insufficient shift cable travel will cause transmission to slip and eventually fail.



72602

a - 2-3/4 In. (70 mm) Minimum

IMPORTANT: The distance between studs (Dimension “C”) shown in the following illustration is set at 7-1/8 in. (318 mm).



73284

8° Down Angle Shown (V-Drive Similar)

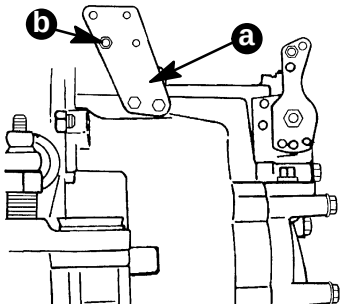
a - Shift Lever
b - Anchor Stud
c - Dimension Between Studs - 7-1/8 In. (318 mm)
d - Shift Cable Bracket

1. Connect and adjust Quicksilver shift cable(s) as outlined following:

⚠ WARNING

Avoid serious injury or property damage caused by improper shifting. Anchor stud for shift cable must be installed in the correct hole.

a. Be certain anchor stud is installed in the front hole as shown in the illustration following.



73284

a - Shift Cable Bracket
b - Anchor Stud in Front Hole

b. Place remote control shift lever and transmission shift lever in neutral position.

c. Remove nuts and washers from shift cable attaching studs.

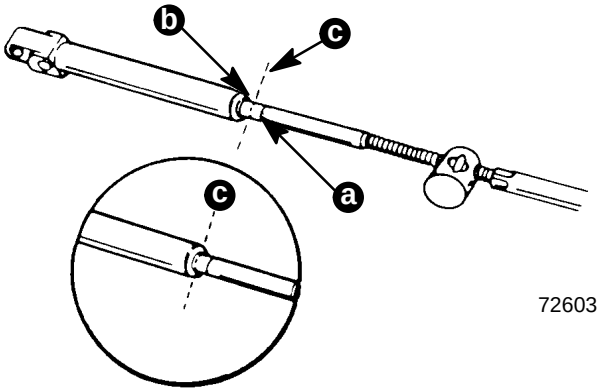
d. Locate center of remote control and control shift cable play (backlash) as follows:

(1) Check that remote control is in neutral position.

(2) Push in on control cable end with enough pressure to remove play; mark position (a) on tube.

(3) Pull out on control cable end with enough effort to remove play; mark position (b) on tube.

(4) Measure distance between marks (a) and (b); mark position (c), half-way between marks (a) and (b).



72603

e. Center cable-end play, then adjust cable barrel to align holes in barrel and in cable end guide, with attaching points on transmission.

f. Temporarily install shift cable. Do not secure at this time.

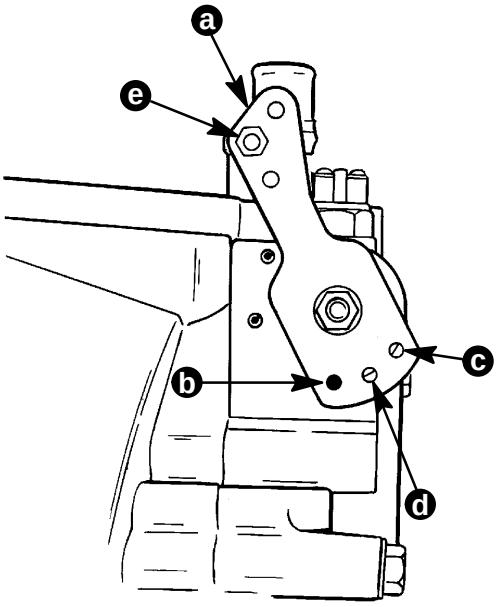
g. Place remote control shift lever in gear and check position of transmission shift lever. Shift lever must be positioned in the desired detent hole.

IMPORTANT: Transmission is "fully" in gear when shift lever comes to a stop, in either direction.

IMPORTANT: Velvet Drive Transmission Warranty is jeopardized if the shift lever poppet ball or spring is permanently removed, if the shift lever is repositioned or changed in any manner or if remote control and shift cable do not position shift lever exactly as shown.

⚠CAUTION

Remote control and shift cable must position transmission shift lever exactly as shown, or transmission failure may occur. Do not remove poppet ball or spring.



73248

Velvet Drive 5000 Series (8° Down Angle Shown, V-Drive Similar)

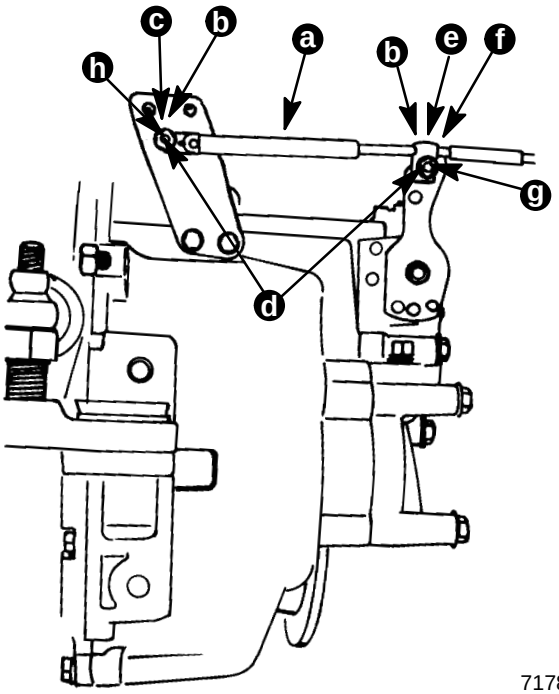
a - Transmission Shift Lever
b - Poppet Ball Must Be Centered in This Detent Hole when Left-Hand Propeller Shaft Rotation Is Desired
c - Poppet Ball Must Be Centered in This Detent Hole when Right-Hand Propeller Shaft Rotation Is Desired
d - Poppet Ball Must Be Centered in This Detent Hole for Neutral Position
e - Install Shift Lever Stud in This Hole when Using Quicksilver Shift Cables

h. Place remote control shift lever in opposite gear position and again check transmission shift lever position. Lever must be positioned in the desired detent hole.

i. If transmission shift lever will not position properly in one gear or both gears, recheck shift cable adjustment and travel as previously instructed in "a"-"h." If proper positioning is still not obtained, remote control does not provide sufficient shift cable travel and must be repaired or replaced.

j. Install nut and washer to cable end guide stud. Tighten until snug, then back off one half turn.

k. Install nut and washer to cable barrel stud. Tighten until they bottom out. Tighten securely, but DO NOT OVER-TIGHTEN.



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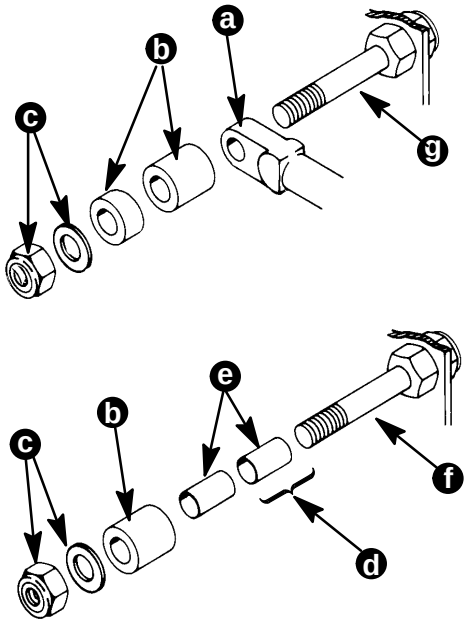
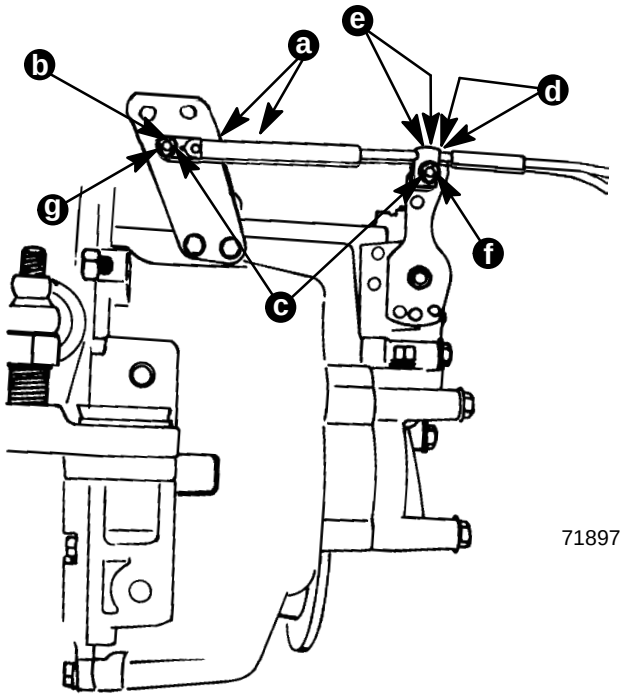


71972

Typical Single Cable Installation - Rear Approach

a - Cable End Guide
b - Spacer (As Required)
c - Elastic Stop Nut and Washer
d - Bushing(s)
e - Cable Barrel Stud
f - Cable End Guide Stud



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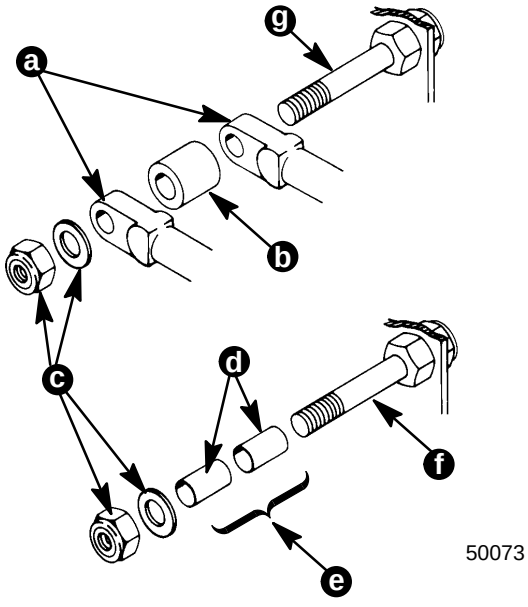

50073

Typical Dual Cable Installation - Rear Approach

a - Cable End Guide
b - Spacer (As Required)
c - Elastic Stop Nut and Washer
d - Bushing(s)
e - Cable Barrel (s) [Position(s) Only Indicated In Lower Drawing]
f - Cable Barrel Stud
g - Cable End Guide Stud

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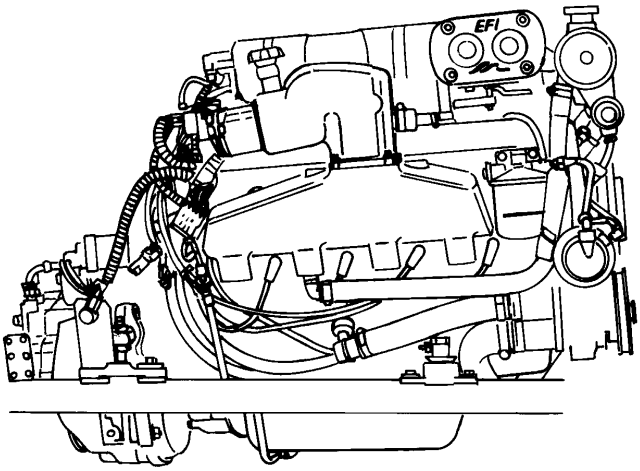
REMOVAL AND INSTALLATION

2

D



74504

MIE MODEL - HURTH TRANSMISSIONS

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Torque Specifications

Fastener Location		Lb. Ft.	N·m
Battery Cables		Securely	
Engine Mount Pads			
Hose Clamps			
Mount Locking Nut			
Propeller Shaft Coupler To Transmission Output Flange		50	68
Trunnion Clamping Screw / Nut			
Remote Control Shift Cable	Cable Barrel	Securely	
	Cable End Guide	NOTE 1	
Remote Control Throttle Cable	Cable Barrel	Securely	
	Cable End Guide	NOTE 1	

NOTE 1: Tighten, then back nut off one half turn.

NOTE 2: Bend tab against adjusting nut.

Lubricants / Sealants

Description	Part Number
Quicksilver 2-4-C Marine Lubricant	92-825407A2
Quicksilver Liquid Neoprene	92-25711--2

Removal

Engine Removal

1. Disconnect battery cables from battery.
2. Remove instrument panel harness connector plug from engine harness receptacle after loosening clamp.

⚠WARNING

Be careful when working on fuel system. Gasoline is extremely flammable and highly explosive under certain conditions. Do not smoke or allow spark or open flame in area. Wipe up any spilled fuel immediately.

3. Using wrench to stabilize brass coupling at fuel filter inlet, disconnect and suitably plug fuel line to prevent fuel in tank from leaking into bilge.
4. Disconnect throttle cable from carburetor and retain locknuts and hardware.
5. Disconnect shift cable from transmission.
6. Disconnect seawater inlet hose from engine.
7. Disconnect exhaust system hoses.
8. Disconnect any grounding wires and accessories that are connected to engine.
9. Disconnect propeller shaft coupler from transmission output flange.

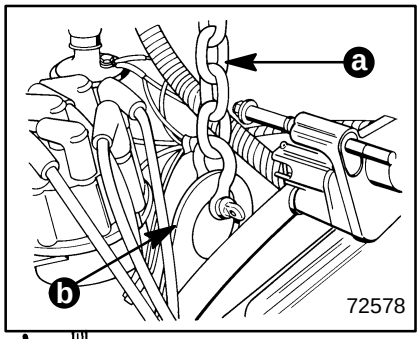
⚠CAUTION

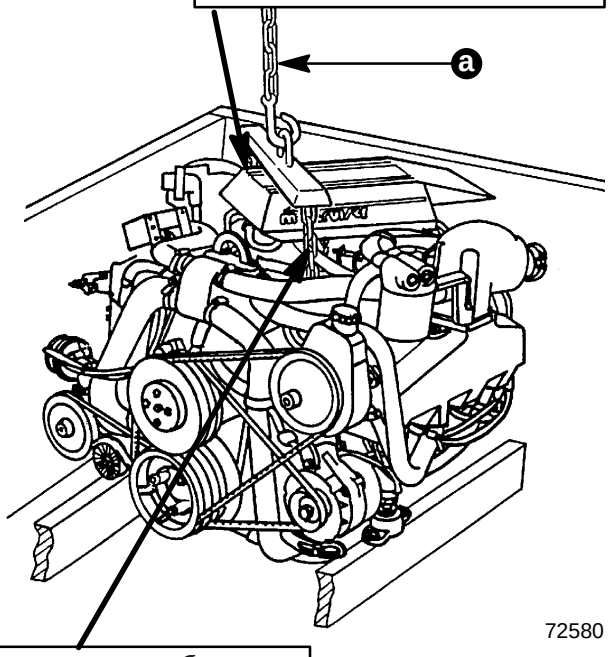
Center lifting eye (located on top of thermostat housing) is used for engine alignment only. DO NOT use to lift entire engine.

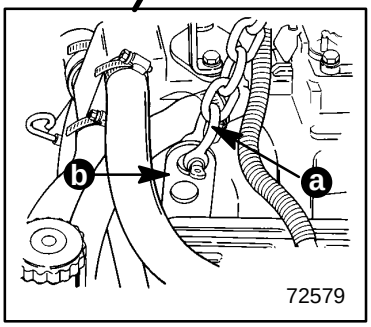
⚠CAUTION

DO NOT allow lifting sling to hook or compress engine components or damage to them will occur.

10. Support engine with suitable sling through lifting eyes on engine.

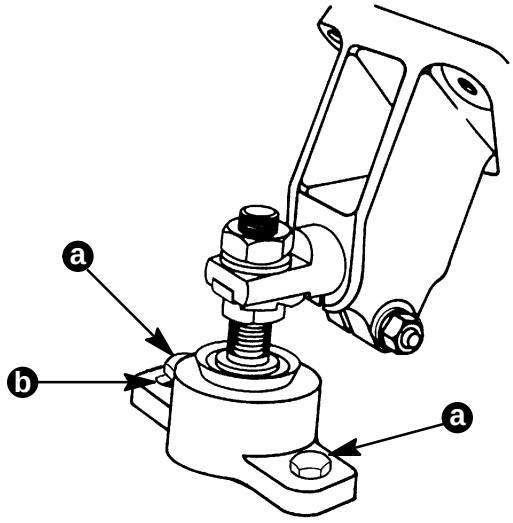






a - Suitable Sling
b - Engine Lifting Eyes

11. Remove front and rear engine mounting bolts. Retain hardware.



72638

All Engines

a - Bolts Or Lag Screws (With Washers)
b - Slot Forward (If So Designed)

12. Carefully remove engine.

Installation

Engine Installation and Initial Alignment

1. Follow instructions “a” or “b”:

   a. **Engine mount(s) or adjustment <u>WAS NOT DISTURBED</u> during engine service:** <u>Proceed to following Step 2.</u>

   b. **Engine mount(s) or adjustment <u>WAS DISTURBED</u> during engine service:**

IMPORTANT: Engine mounts must be adjusted, as explained in the following, to center mount adjustment and establish a uniform height on all mounts.

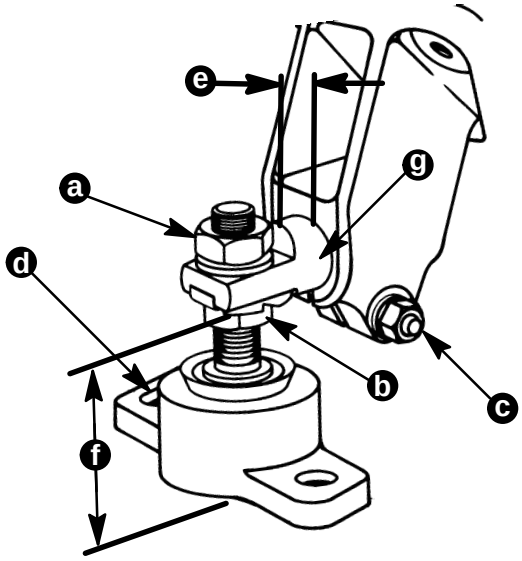
Ensure that all mounts are:

(1) In the center of their up-and-down adjustment.

(2) Mounting hole, which is a slot, is forward (if so designed; new style is not slotted).

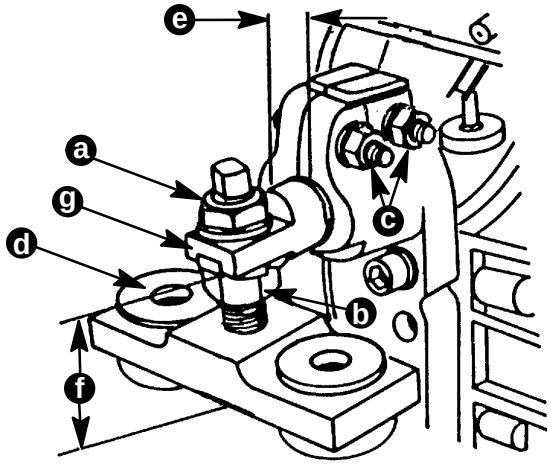
(3) Large diameter of mount trunnion extended as shown.

(4) Each mount base is downward. Tighten clamping screws and nuts slightly to prevent moving in or out. Mounts must be free to pivot when installing engine.



70140

Front Mount - Typical



Rear Mount - Typical

70158

a - Locking Nut
b - Adjusting Nut
c - Trunnion Clamp Screw and Nut, With Lockwasher
d - Slot Forward
e - 3/8 In. ± 1/16 In. (10 mm ± 2 mm)
f - 2-5/8 In. ± 1/16 In. (67 mm ± 2 mm)
g - Mount Trunnion

⚠CAUTION

Center lifting eye (located on top of thermostat housing) is used for engine alignment only. DO NOT use to lift entire engine.

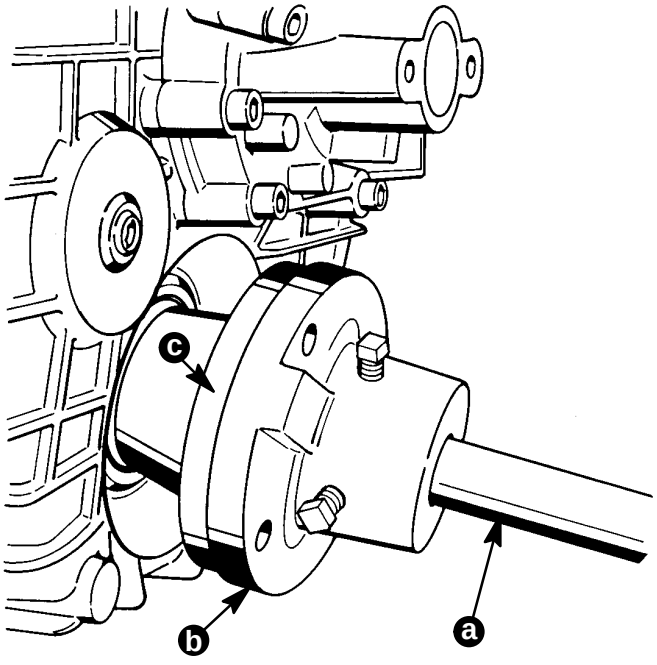
⚠CAUTION

DO NOT allow lifting sling to hook or compress engine components or damage to them will occur.

2. Attach a suitable sling to lifting eyes on engine. **(Refer to "Removal" section for location of lifting eyes.)**

IMPORTANT: Engine bed must position engine so that a minimum of 1/4 in. (6 mm) up-and-down adjustment still exists on all four mounts after performing final alignment. This is necessary to allow for final engine alignment.

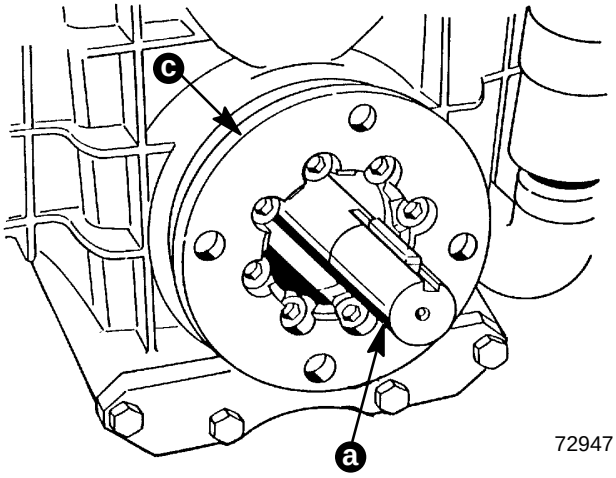
a. **Models with Down Angle Transmission:** Lift engine into boat and position on engine bed so that transmission output flange and propeller shaft coupler are visibly aligned so no gap can be seen between coupling faces when butted together. **Adjust engine bed height,** if necessary, to obtain proper alignment. DO NOT use mount adjustments to adjust engine position at this time.



72596

a - Propeller Shaft
b - Propeller Shaft Coupler
c - Transmission Output Flange

b. **Models with V-Drive Transmission:** Lift engine into boat and position on engine bed so that enough propeller shaft protrudes through transmission and output flange for propeller shaft coupler to be attached. Then, install coupler and position engine so no gap can be seen between coupling faces when butted together. **Adjust engine bed height**, if necessary, to obtain proper alignment. DO NOT use mount adjustments to adjust engine position at this time.



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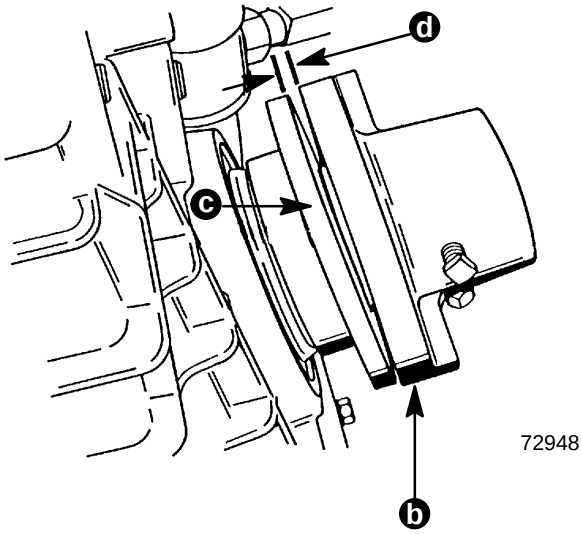


72948

a - Propeller Shaft
b - Propeller Shaft Coupler
c - Transmission Output Flange
d - No Gap Allowed

3. Check all four mounts to ensure that they are still positioned properly, then fasten mounts to engine bed with appropriate bolts or lag screws and hardware. Tighten lag bolts/screws securely.

4. Disconnect and remove sling. Proceed to "Engine Final Alignment" section follow

Engine Final Alignment

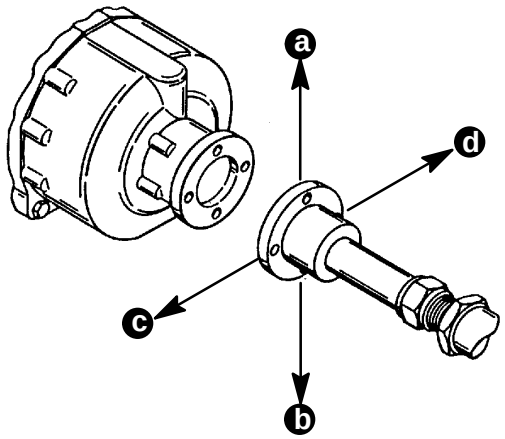
⚠CAUTION

To avoid vibration, noise and damage to transmission output shaft oil seal and bearings, engine must be properly aligned.

IMPORTANT: Engine alignment MUST BE RECHECKED with boat in the water, fuel tanks filled and with a normal load on board.

Engine must be aligned so that transmission output flange and propeller shaft coupler centerlines are aligned and coupling faces are parallel within .003 in. (0.07mm). This applies to installations with solid couplings, as well as flexible couplings.

1. Check mating surfaces on transmission output flange and propeller shaft coupler faces to make sure they are clean and flat.
2. Follow instructions “a” or “b”:
   a. **On V-Drive Transmission Models:** Proceed to Step 3.
   b. **On Down Angle Transmission Models:** Center propeller shaft in shaft log as follows:
      (1) Push down and then lift shaft as far as it will move. Then place shaft in the middle of the movement.
      (2) Move shaft to port and then to starboard as far as shaft will move. Then place shaft in the middle of the movement.
      (3) With shaft in center of shaft log, as determined by above procedures (1) and (2), align engine to shaft.

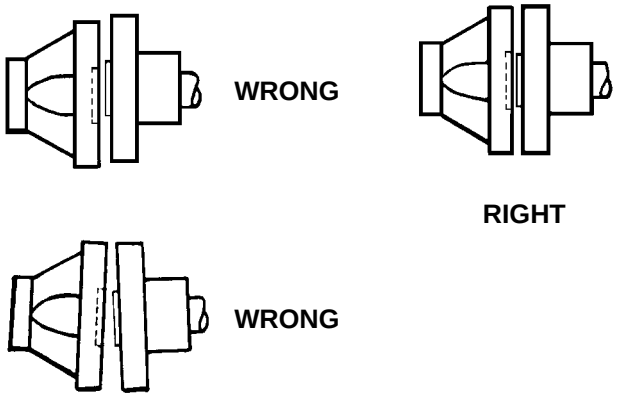


72595

a - Up
b - Down
c - Port
d - Starboard

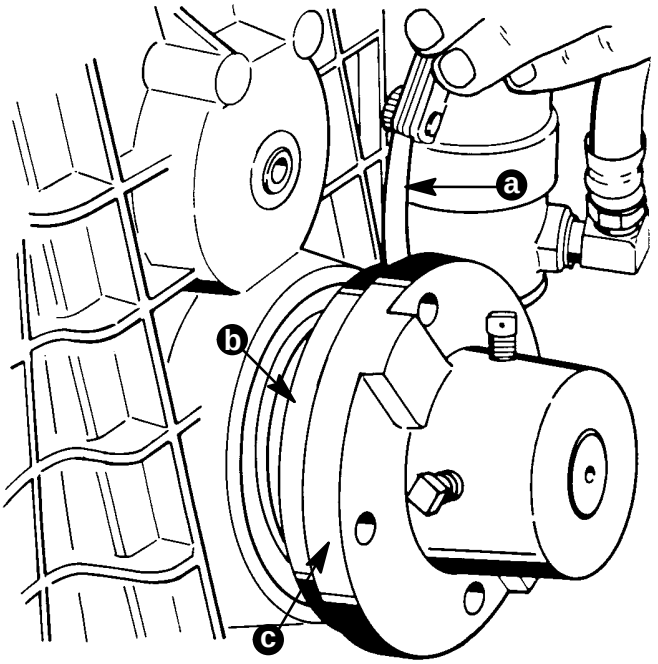
3. Check that coupling centerlines align, by butting propeller shaft coupler against transmission output flange. Shoulder on propeller shaft coupler should engage recess on transmission output flange face with no resistance.

NOTE: *Some propeller shaft couplers may not have a shoulder on mating face. On these installations, use a straight edge to check centerline alignment.*



72597

4. Check for angular misalignment, by hand holding coupling faces tightly together; check for a gap between faces with a .003 in. (0.07 mm) feeler gauge at 90° intervals.



50609

V-Drive Shown - Down Angle Similar

a - Feeler Gauge (Check At (90 Degree Intervals)
b - Transmission Output Flange
c - Propeller Shaft Coupler

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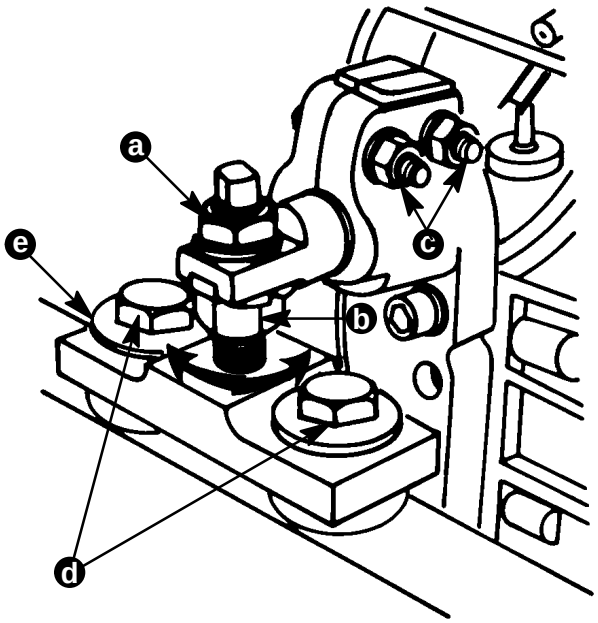
5. If coupling centerlines are not aligned or if coupling faces are more than .003 in. (0.07 mm) out of parallel, adjust and retighten engine mounts as follows:

   a. TO ADJUST ENGINE UP OR DOWN: Loosen locking nut on mounts requiring adjustment and turn both front mount or rear mount adjusting nuts equally.

IMPORTANT: Both front mount (or rear mount) adjusting nuts must be turned equally to keep engine level from side to side.



70056

Typical Mount

a - Locking Nut
b - Adjusting Nut
c - Clamping Screws and Nuts, With Lockwashers (Two Each on Some Models)
d - Lag Screws (Or Bolts)
e - Slot Forward (If So Designed - NOT Slotted On This Style Rear Mount)

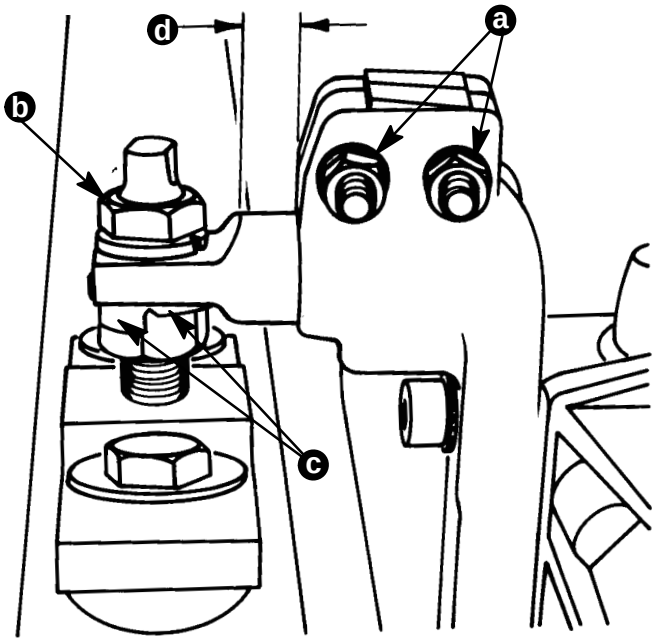
NOTE: *Engine mount shown is typical. All models are similar and adjust in the same manner.*

   b. TO MOVE ENGINE TO THE LEFT OR RIGHT: Loosen clamping screw and nut on all four mount brackets; move engine to the left or right as necessary to obtain proper alignment. On mounts which do have a slotted hole, a small amount of adjustment can be obtained with slot on front end of mounts. Loosen lag screws or bolts (which fasten mounts to engine bed) and move engine, as required. Tighten lag screws or bolts securely.

   c. After engine has been properly aligned: Tighten engine mount nuts securely, and be certain to bend one of the tabs on the tab washer down onto flat of mount adjusting nut. Torque clamping screws and nuts to 50 lb. ft. (68 N·m).

NOTE: *Some rear mounts have only one clamping screw and nut on each side, instead of the style with two shown following.*

IMPORTANT: Large diameter of mount trunnion MUST NOT extend over 3/4 in. (20 mm) from mount brackets on any of the mounts.



70057

a - Torque Clamping Screw and Nut On All Four Mount Brackets To 50 Lb. Ft (68 N·m)
b - Tighten Locking Nut On All Four Mounts Securely
c - Bend One Of The Tab Washer Down Onto Flat Of Adjusting Nut
d - Maximum Extension Of Large Diameter Of Trunnion - 3/4 In. (20 mm)

IMPORTANT: All coupler bolts must be Grade 8 (Metric Grade 10.9) or better, with a shoulder (grip length) long enough to pass through the face mating plane of couplers.

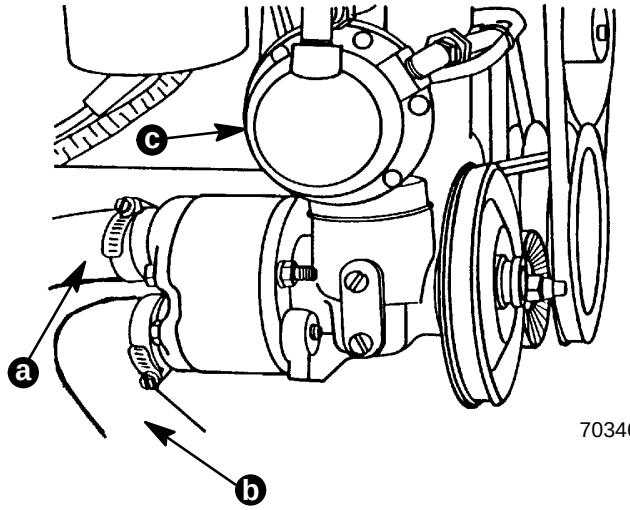
6. Connect propeller shaft coupler to transmission output flange. Attach couplers together with bolts, lockwashers and nuts. Torque to 50 lb.ft. (68 N·m).

NOTE: *If propeller shaft coupler has setscrews, the shaft should be dimpled at setscrew locations. Setscrews should be safety wired after being tightened securely.*

Engine Connections

IMPORTANT: When routing all wire harnesses and hoses, be sure they are routed and secured to avoid coming in contact with hot spots on engine and avoid contact with moving parts.

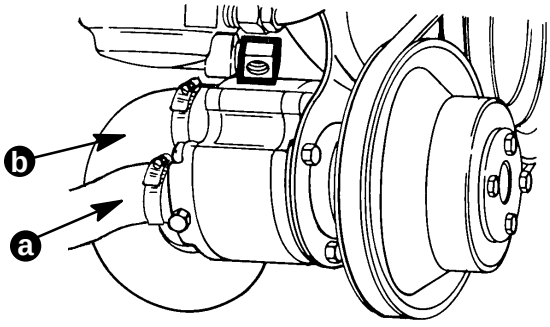
1. Connect seawater inlet hose to combination seawater/fuel pump assembly as shown. Tighten hose clamp securely.



70346

Engines With Combination Seawater / Fuel Pump

a - Seawater Inlet Hose
b - Hose To Cooler
c - Fuel Pump

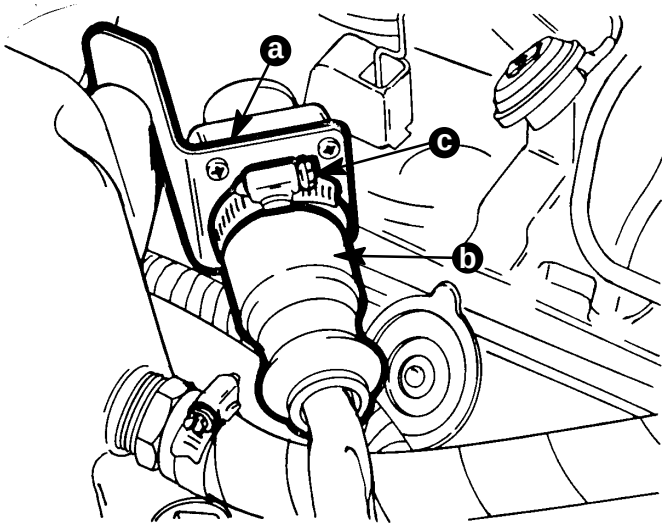


72352

Engines Without Mechanical Fuel Pump

a - Seawater Inlet Hose
b - Hose To Cooler

2. Connect instrument harness to engine harness with hose clamp. Tighten hose clamp securely.



22557

Harness Connection

a - Engine Wiring Harness Receptacle Bracket
b - Instrument Wiring Harness Plug
c - Hose Clamp

FUEL SUPPLY CONNECTIONS

⚠WARNING

Avoid gasoline fire or explosion. Improper installation of brass fittings or plugs into fuel pump or fuel filter base can crack casting and/or cause a fuel leak.

- **Apply #592 Loctite Pipe Sealant with Teflon to threads of brass fitting or plug. DO NOT USE TEFLON TAPE.**
- **Thread brass fitting or plug into fuel pump or fuel filter base until finger tight.**
- **Tighten fitting or plug an additional 1-3/4 to 2-1/4 turns using a wrench. DO NOT OVER-TIGHTEN.**
- **Install fuel line. To prevent over-tightening, hold brass fitting with suitable wrench and tighten fuel line connectors securely.**
- **Check for fuel leaks.**

⚠WARNING

Be careful when working on fuel system. Gasoline is extremely flammable and highly explosive under certain conditions. Do not smoke or allow spark or open flame in area. Wipe up any spilled fuel immediately.

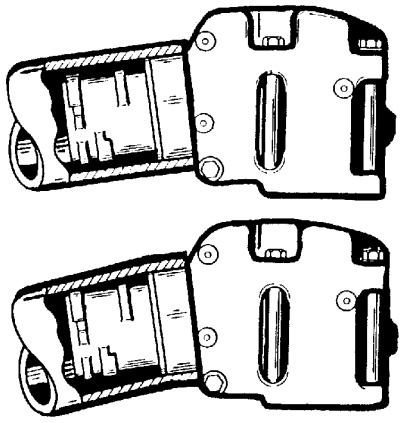
3. Connect fuel line from fuel tank(s) to engine. Make certain connection is secure. Check for leaks.
4. Connect exhaust system tubes and hoses using at least two hose clamps at each connection. Tighten hose clamps securely.

NOTICE

Exhaust hoses must be connected to exhaust elbows so that they do not restrict the flow of discharge water from exhaust elbow. If hoses are connected incorrectly, discharge water from exhaust elbow will not flow around entire inside diameter of hose. This will cause a hot spot in the hose which may eventually burn through.

CORRECT

INCORRECT



72538

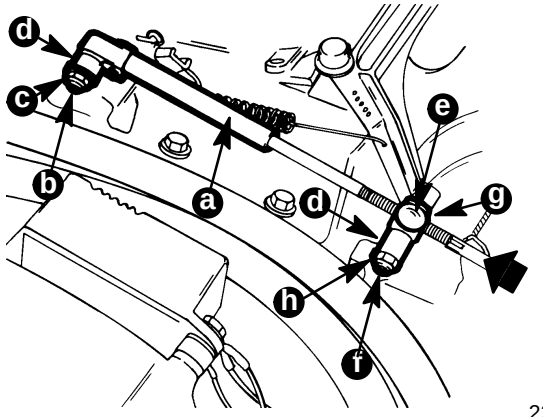
NOTE: *Clamps not shown.*

Throttle Cable Installation and Adjustment

Weber 4 Barrel Carburetor

IMPORTANT: When installing throttle cable, be sure that cables are routed in such a way as to avoid sharp bends and/or contact with moving parts. DO NOT fasten any items to throttle cable.

1. Lubricate cable ends and barrels.
2. Place remote control throttle lever in idle position and attach cable end guide to carburetor throttle lever as shown.
3. Grasp cable behind barrel and push lightly as shown. Adjust cable barrel to align hole with anchor stud, then slide barrel onto stud.



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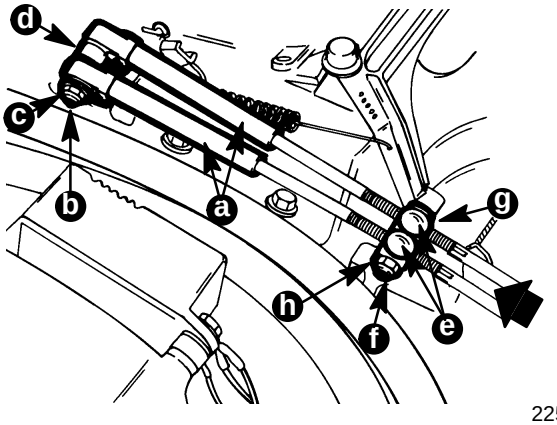
Single Station

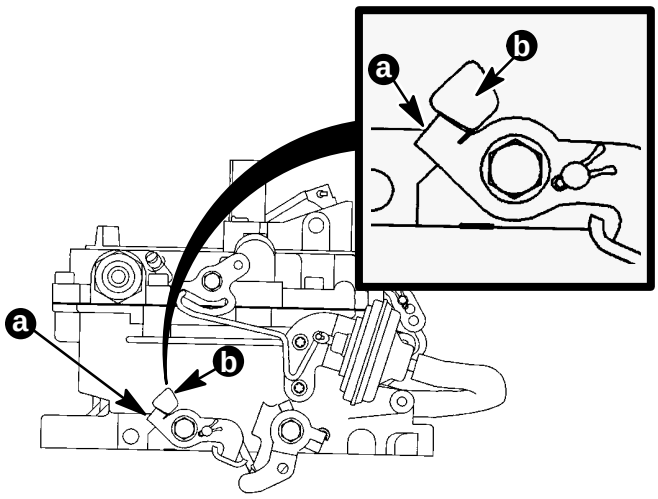


22553

Dual Station

a - Throttle Lever Stud
b - Elastic Stop Nut and Washer
c - Spacer
d - Cable Barrel
e - Anchor Stud
f - Washer
g - Elastic Stop Nut
h - Cable End Guide

4. Secure throttle cable with hardware as shown and tighten securely. DO NOT OVERTIGHTEN, as cable must pivot freely.
5. Place remote control throttle lever in the wide open throttle (W.O.T.) position. Check to ensure that throttle plates are completely open.
6. Return remote control throttle lever to idle position and check to ensure that throttle lever contacts idle speed adjustment screw.



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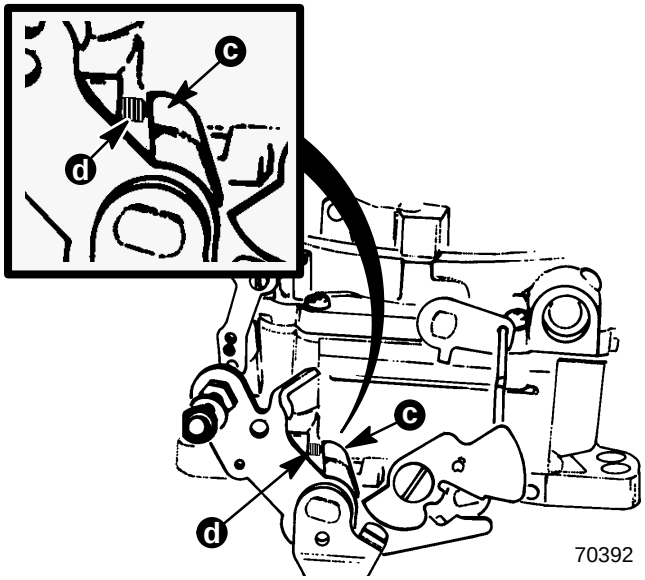


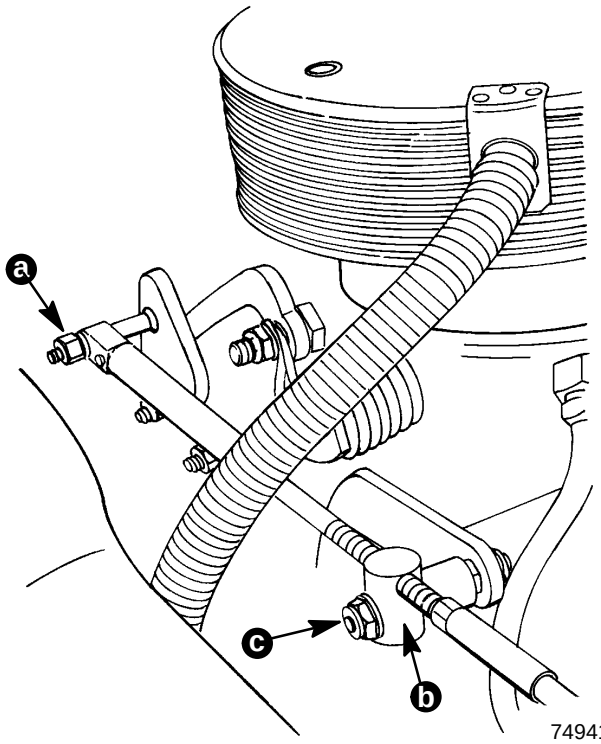
70392

a - Throttle Shaft Lever [Contacts (b) at W.O.T. Position]
b - Carburetor Body Casting
c - Throttle Lever [Contacts (d) in Idle Position]
d - Idle Speed Adjustment Screw

Throttle Body Injection

IMPORTANT: When installing throttle cable, be sure that cables are routed in such a way as to avoid sharp bends and/or contact with moving parts. DO NOT fasten any items to throttle cable.

1. Place remote throttle lever in idle position and attach cable to throttle body, following cable manufacturer's instructions.
2. Install cable end guide on throttle lever, then push cable barrel end lightly toward throttle lever end. (This will place a slight preload on shift cable to avoid slack in cable when moving remote control lever.) Adjust barrel on throttle cable to align with hole in anchor plate. Ensure hole in barrel positions cable as shown.



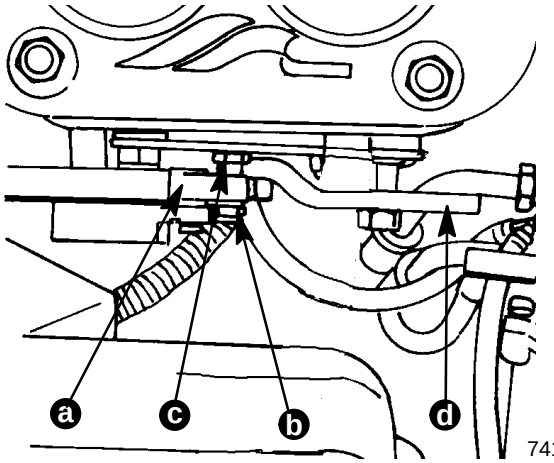
74941

a - Cable End
b - Cable Barrel
c - Locknut and Flat Washer - Tighten Until Nut Bottoms Out Then Back Off One-Half Turn

Multi-Port Injection

IMPORTANT: When installing throttle cable, be sure that cables are routed in such a way as to avoid sharp bends and/or contact with moving parts. DO NOT fasten any items to throttle cable.

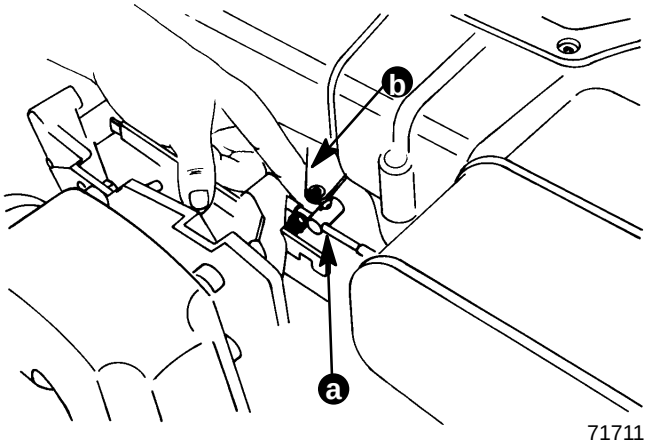
1. Lubricate cable ends and barrels.
2. Place remote throttle lever in idle position and attach cable to throttle body, following cable manufacturer's instructions.



74174

a - Cable End Guide
b - Throttle Lever Stud
c - Locknut and Flat Washer - Tighten Until Nut Bottoms Out Then Back Off One-Half Turn
d - Throttle Lever

3. Install cable end guide on throttle lever, then push cable barrel end lightly toward throttle lever end. (This will place a slight preload on shift cable to avoid slack in cable when moving remote control lever.) Adjust barrel on throttle cable to align with hole in anchor plate. Ensure hole in barrel positions cable as shown.



71711

a - Cable Barrel
b - Anchor Plate

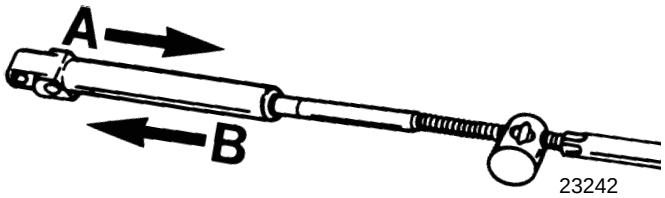
Shift Cable Installation And Adjustment

IMPORTANT: These Hurth transmissions are full reversing transmissions. Direction of output/ propeller rotation is determined by hookup of shift cable at remote control.

Shift cable must be hooked up to remote control before starting installation and adjustment procedures. Refer to "Transmission - Propeller Rotation", as previously outlined in the front of this manual, for transmission shift lever direction of movement versus propeller shaft output direction of rotation.

For Right Hand Propeller Rotation – Shift cable hookup at remote control must result in shift cable end guide moving in direction **"A",** when remote control handle is placed in forward position.

For Left Hand Propeller Rotation – Shift cable hookup at remote control must result in shift cable end guide moving in direction **"B",** when remote control handle is placed in forward position.



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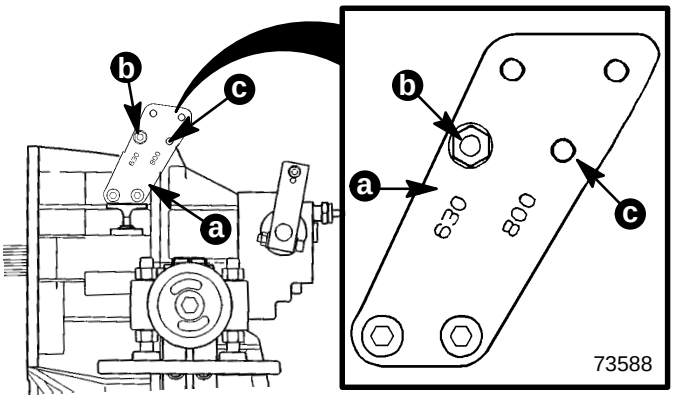
⚠WARNING

Avoid serious injury or property damage caused by improper shifting. Anchor stud for shift cable must be installed in the correct hole.

1. Be certain anchor stud is installed in the correct mount hole as shown by the following illustration.



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Shift Cable Bracket - Anchor Stud Positions

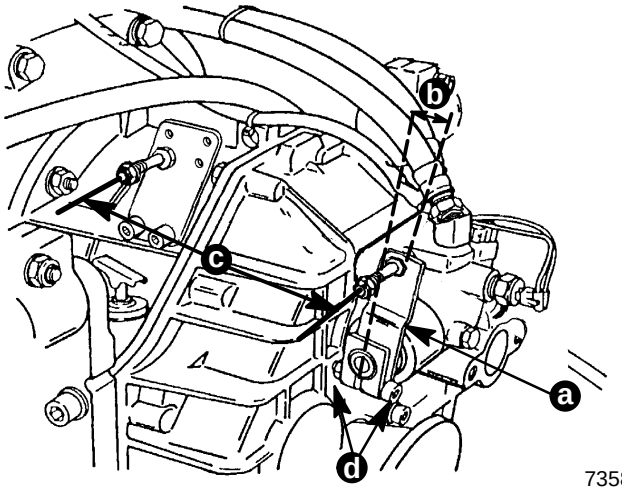
a - Cable Bracket
b - Quicksilver Shift Cable Anchor Stud Location - 630A and 630V
c - Quicksilver Shift Cable Anchor Stud Location

Index

IMPORTANT: When installing shift cables, be sure that cables are routed in such a way as to avoid contact with moving parts and/or sharp bends [all bends must make greater than an 8 inch (203 mm) radius]. DO NOT fasten any items to shift cables.

2. Check shift lever positioning as indicated:

IMPORTANT: Check that shift lever is positioned approximately 10° aft of vertical when in the neutral detent position and that the distance ("c") between studs in the following is set at 7-1/8 in. (318mm). If necessary, loosen clamping bolt and position lever so that dimension "c" is as shown when in the neutral detent position and retighten bolt.

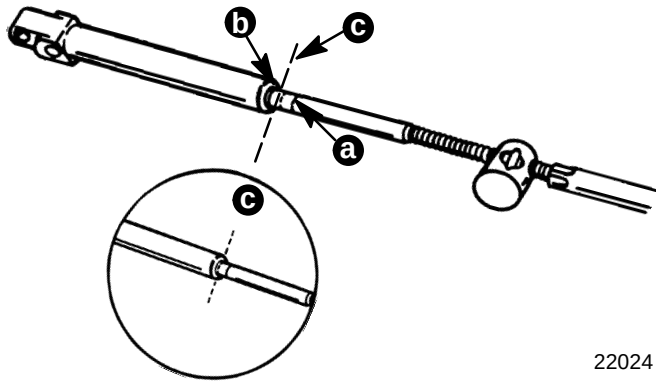


73587

Typical Hurth Transmission Shown

a - Shift Lever
b - Lever, in Neutral Detent, Must Be Approximately 10° Aft of Vertical
c - Dimension Between Studs - 7-1/8 in. (318mm)
d - Clamping Bolt

3. Place remote control shift lever, and transmission shift lever, in neutral position.
4. Remove nuts and washers from shift cable attaching studs.
5. Locate center of remote control and control shift cable play (backlash), as follows:
   a. Check that remote control is in neutral position.
   b. Push in on control cable end with enough pressure to remove play, and mark position "a" on tube.
   c. Pull out on control cable end with enough pressure to remove play, and mark position "b" on tube.
   d. Measure distance between marks "a" and "b," and mark position "c," half-way between marks "a" and "b."



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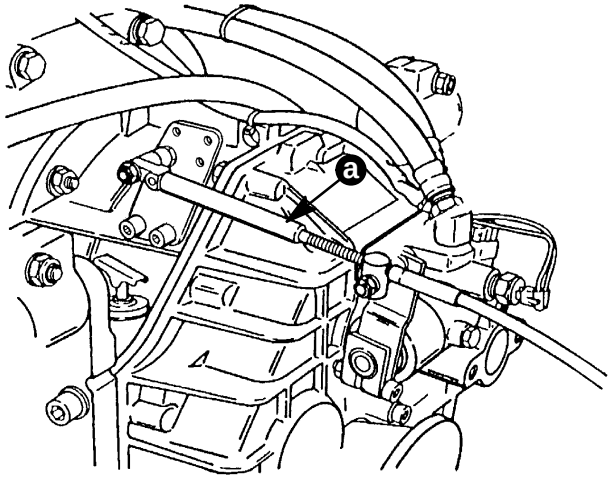
6. Center cable-end play, then adjust cable barrel to align holes in barrel, and in cable end guide, with attaching points on transmission.
7. Temporarily install shift cable. Do not secure at this time.



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Typical

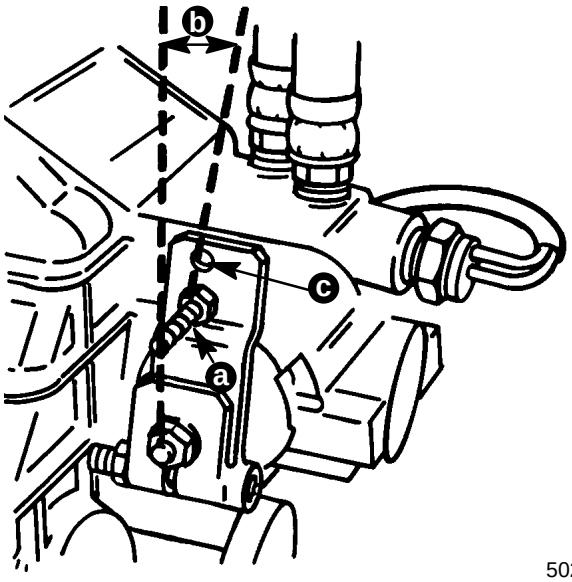
a - Shift Cable End Guide

IMPORTANT: Transmission is "fully" in gear when shift lever comes to a stop, in either direction.

8. Place remote control shift lever in forward gear position. Check to ensure transmission is fully in gear, as follows:
   a. Hold shift lever in position.
   b. Carefully slide shift cable off of anchor points.
   c. Attempt to move shift lever further.

9. Place remote control shift lever in the reverse gear position. Check that transmission is fully in gear, following same procedure.

10. If transmission shift lever will position properly in one gear, but not in the other, recheck shift cable adjustment. If transmission shift lever will not position properly in both gears, move transmission shift lever stud (a), from top hole in shift lever, to bottom hole, and recheck for proper positioning. If proper positioning is still not obtained, remote control does not provide sufficient shift cable travel and must be replaced.



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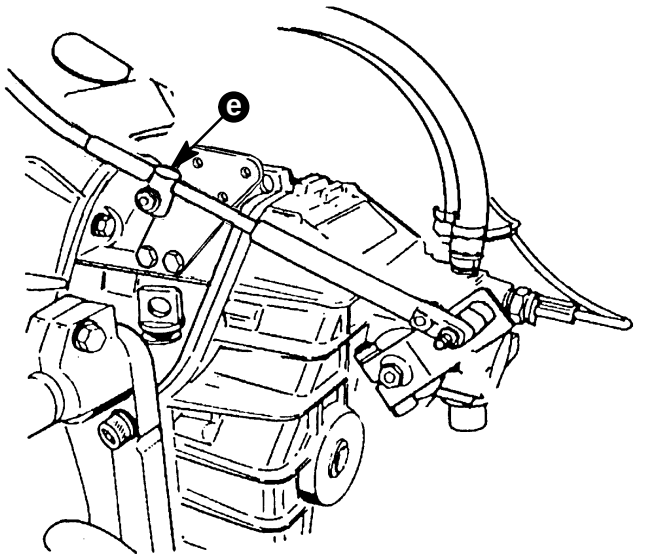
a - Shift Lever Stud (In Bottom Hole, If Required)
b - Lever, in Neutral Detent, Must Be Approximately 10° Aft of Vertical
c - Shift Lever Top Hole

11. Reattach locknut and washer to cable end guide stud. Tighten until snug, then back off one-half turn.

12. Reattach locknut and washer to cable barrel stud. Tighten until they bottom out. Tighten securely, but do not overtighten.

NOTE: *To change cable approach direction on single or dual station installations, only the spacers/bushings have to be switched to the opposite stud (the studs are identical).*



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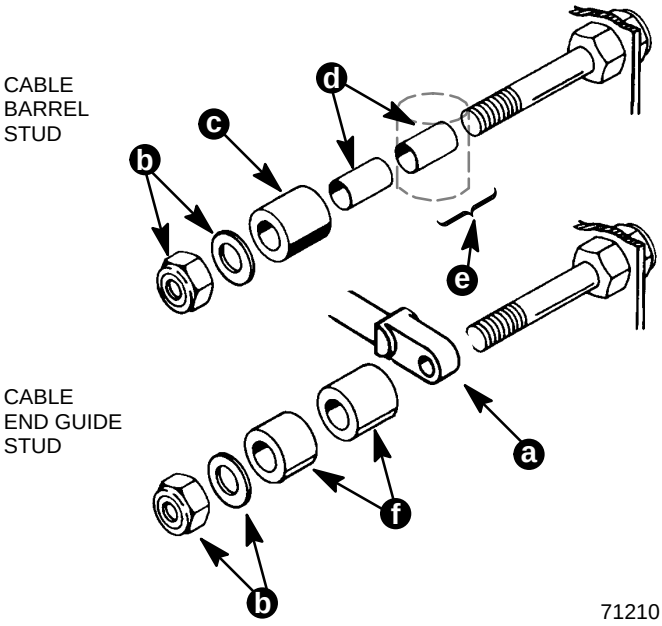
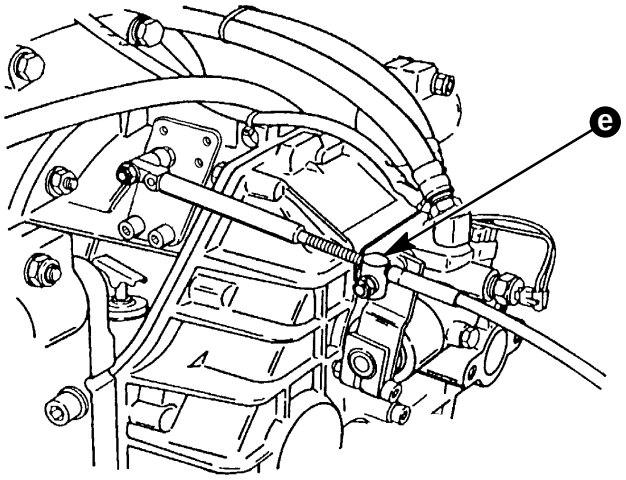


71210

Typical Single Cable - Forward Entry

a - Cable End Guide
b - Locknut and Washer
c - Spacer (Fits over Bushings)
d - Bushings
e - Cable Barrel Location
f - Spacer (Fit over Stud)



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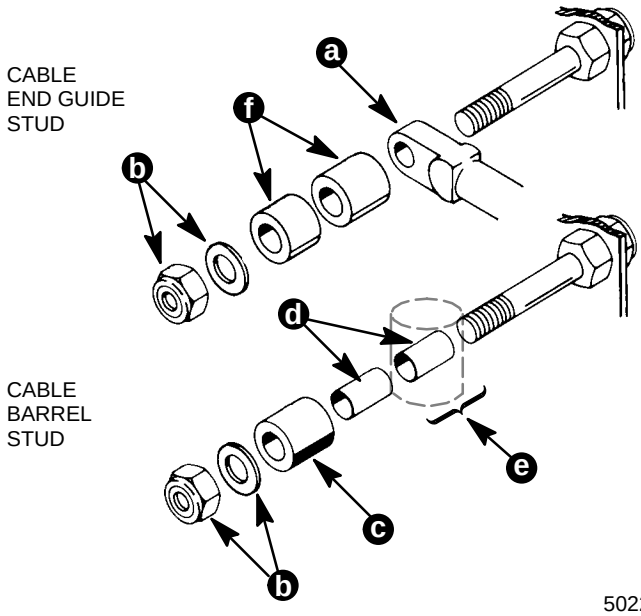
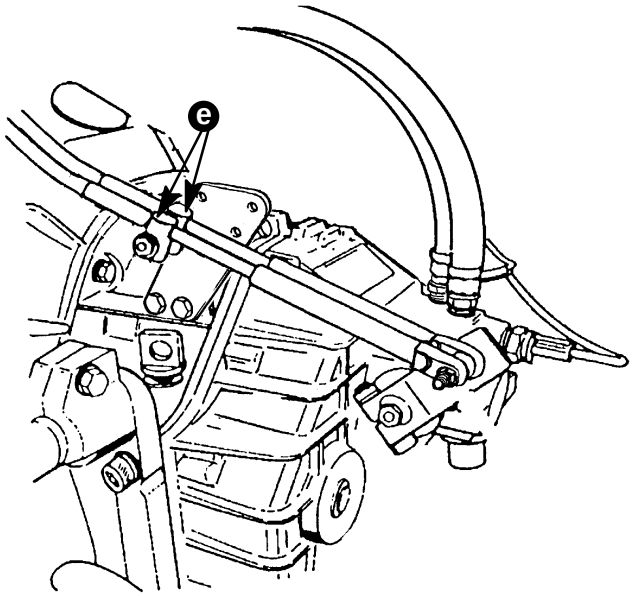


50229

Typical Single Cable - Rear Entry

a - Cable End Guide
b - Locknut and Washer
c - Spacer (Fits over Bushings)
d - Bushings
e - Cable Barrel Location
f - Spacer (Fit over Stud)



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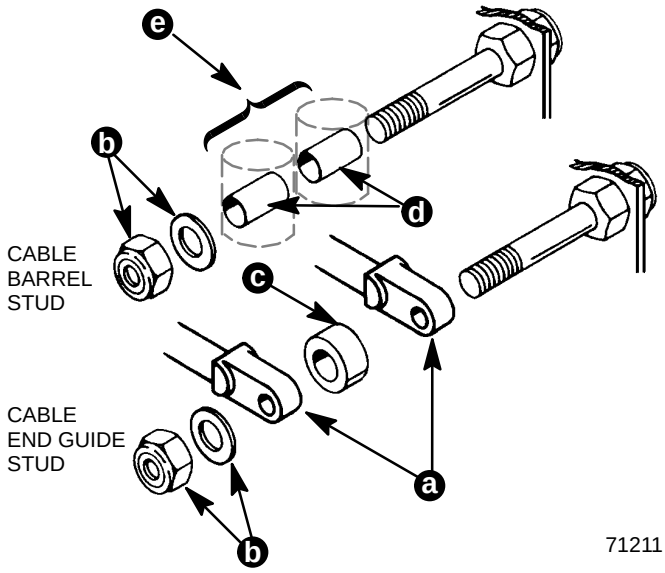
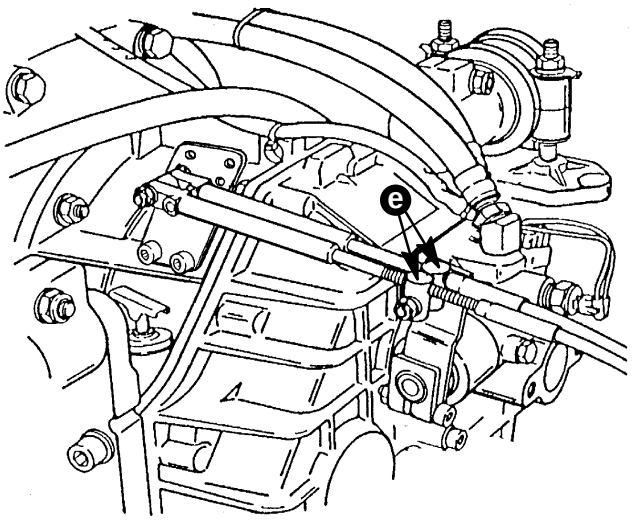


71211

Typical Dual Cable - Forward Entry

a - Cable End Guides
b - Locknut and Washer
c - Spacer (Fits over Stud)
d - Bushings
e - Cable Barrel Locations



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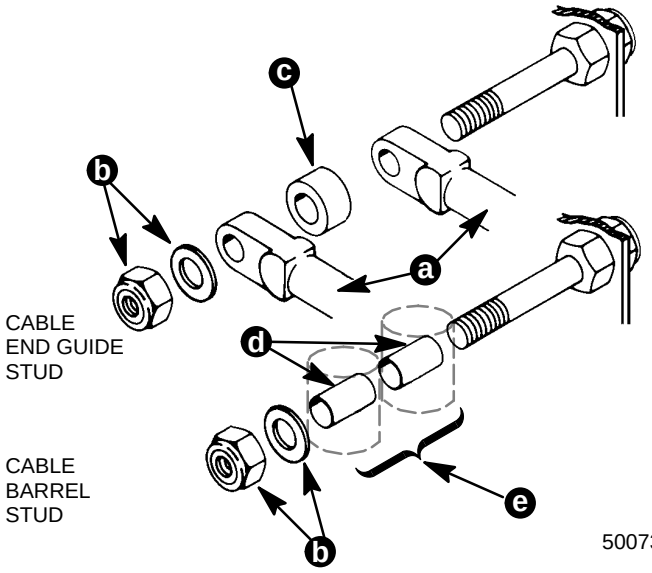

50073

Typical Dual Cable - Rear Entry

a - Cable End Guides
b - Locknut and Washer
c - Spacer (Fits over Stud)
d - Bushings
e - Cable Barrel Locations

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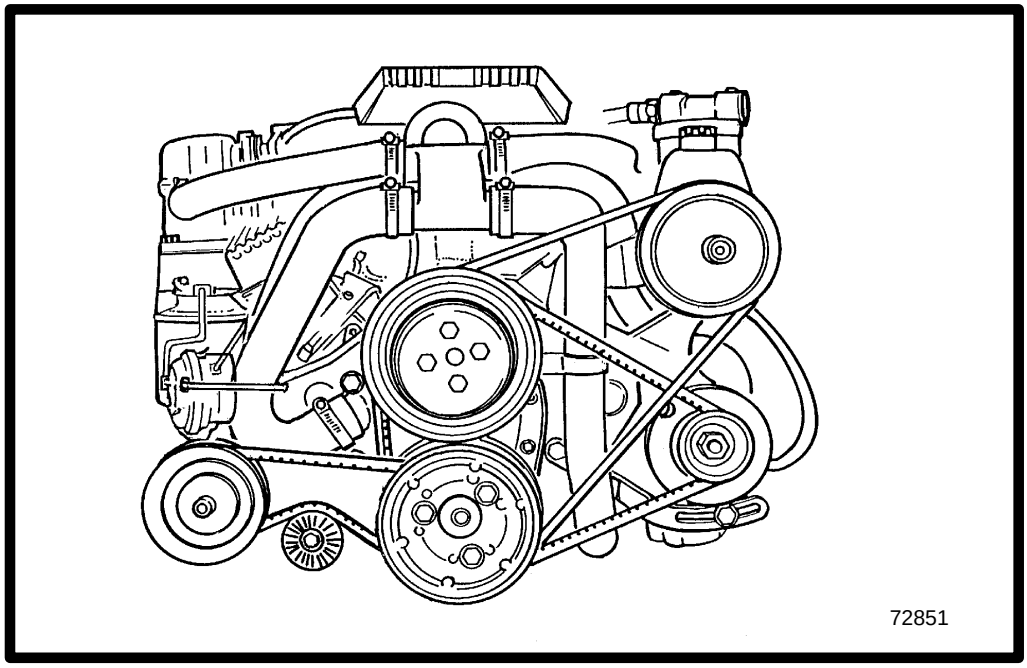
ENGINE

3
A



454 CID (7.4L) / 502 CID (8.2L)

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Torque Specifications

DESCRIPTION		Lb. In.	Lb. Ft.	N·m
Alternator Brace to Alternator		192		9
Alternator Brace to Engine			30	41
Alternator to Mounting Bracket			35	48
Alternator Mounting Bracket			30	41
Camshaft Sprocket Gear			18	24
Carburetor		132		15
Connecting Rod Caps	(3/8-24 Nuts)		50	68
	(7/16-20 Nuts)		73	99
Coupler/Flywheel(MCM)			35	48
Crankcase Front Cover		120		14
Crankshaft Pulley			35	48
Cylinder Head			85	115
Distributor Hold Down			20	27
Exhaust Manifold			30	41
Exhaust Manifold Elbow			30	41
Filter Adapter (5/16-18)			20	27
Flywheel			75	100
Flywheel Drive Plate (MIE)			35	48
Flywheel Housing to Block			30	41
Flywheel Housing Cover		80		9
Front Mount Bracket			30	41
Fuel Pump			25	34
Intake Manifold			35	48 (See Note)
Main Bearing Cap			110	149
Oil Baffle Nuts			25	34
Oil Filter Adapter Nuts			40	54
Oil Pan Bolts (5/16-18)		80		9
Oil Pan Drain Plug			15	20
Oil Pump			70	95
Oil Pump Cover		80		9
Power Steering Pump Brace to Block			30	41
Power Steering Pump Bracket			30	41
Rear Mount (MCM)			40	54
Rear Mount (MIE)			50	68
Remote Oil Connector (1/2 in. x 13)			25	34
Rocker Arm Cover		90		10
Rocker Arm Bolts	7.4L/454		40	54
	454 Magnum/502		45	61

Note: 7.4L / 454 and 502 Multi-Port engines, Torque intake manifold fasteners to 25-30 Lb. Ft. (34 [illegible] m).

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Torque Specifications (Continued)

DESCRIPTION	Lb. Ft.	N·m
Remote Oil Filter Adapter Nut/Fitting	20	27
Seawater Pump Brace	30	41
Seawater Pump Bracket	30	41
Spark Plugs	15	20
Starter Motor	50	68
Thermostat Housing	30	41
Torsional Damper	40	54
Transmission To Housing	50	68
Water Circulating Pump	35	48
Water Temperature Sender	20	27

Special Tools

MERCURY MARINE SPECIAL TOOLS	
DESCRIPTION	**PART NUMBER**
Piston Ring Expander	91-24697
Engine Coupler Wrench	91-35547

KENT-MOORE SPECIAL TOOLS	
DESCRIPTION	**PART NUMBER**
Valve Spring Compressor (Head on)	J5892
Valve Spring Compressor (Head off)	J8062
Valve Spring Tester	J8056
Valve Guide Cleaner	J8101
Carbon Remover Brush	J8089
Piston Pin Tool	J24086-B
Piston Ring Groove Cleaner	J3936-03
Piston Ring Compressor	J8037
Connecting Rod Guide Tool (3/8 -24)	J5239
Connecting Rod Guide Tool (7/16-20)	J35228
Oil Pump Suction Pipe Installer	J21882
Lift Indicator Tool	J8520
Torsional Damper Remover and Installer	J23523-E
Crankcase Front Cover Seal Installer	J22102
Crankshaft Gear and Sprocket Puller	J24420-B
Crankshaft Gear and Sprocket Installer	J20158-20
Air Adapter (Cylinder Inflator)	J23590
Main Bearing Remover and Installer	J8080
Rear Main Seal Installer	J38841

Lubricants/Sealers/Adhesives

DESCRIPTION	PART NUMBER
Quicksilver Loctite 8831	92-32609-1
Quicksilver Perfect Seal	92-34227-1
Quicksilver RTV Sealer	92-91601-1
General Motors Cam and Lifter Prelube or Equivalent	Obtain Locally

Gen V And Gen VI (Except 7.4L Gen VI) Engine Specifications

UNIT OF MEASUREMENT In. (mm)

DISPLACEMENT	7.4L	454 MAGNUM	502 MAGNUM / 8.2L
Bore	4.25 (108)		4.46 (113.28)
Stroke	4.00 (101.6)		
Compression Ratio	8.0:1	8.6:1	8.75:1
Heads	Cast Iron (Oval Port)	Cast Iron (Rectangular Port)	
Intake Manifold	Cast Iron (Note 3)	Aluminum With Brass Inserts-High Rise (Note 1)	
Block	Cast Iron (4 Bolt Main Bearing Caps)		
Rods	Forged Steel		
Pistons	Cast Aluminum (Note 2)	Forged Aluminum	
Crankshaft	Cast Steel	Forged Steel	
Camshaft	Cast Iron (Gen V) Steel (Gen VI)		

Note 1: 7.4L / 454 and 502 Magnum Multi-Port engine is equipped with a cast aluminum intake manifold with brass inserts.

Note 2: 7.4L Bravo Three engines with engine code
UB with serial number OF1589289 and lower will have forged pistons.
XX with serial number OF159290 and higher will have cast pistons

Note 3: Serial numbers OD838819 thru OF800699 are equipped with cast aluminum intake manifolds.

CYLINDER BORE

IMPORTANT: 7.4L Bravo Three engines with engine code UB with serial number OF1589289 and lower have forged pistons. The piston specifications for the 454 Magnum must be used.

ENGINE			7.4L	454 MAGNUM	502 MAGNUM/ 8.2L
Diameter			4.2500-4.2507 (107.950-107.967)	4.2451-4.2525 (107.826-108.013)	4.4655-4.4662 (113.423-113.441)
Out of Round		Production	.001 (0.025) Max		
		Service	.002 (0.05) Max		
Taper	Production	Thrust Side	.0005 (0.0127) Max		
		Relief Side	.001 (0.0254) Max		
	Service		.001 (0.02) Over Production		

PISTON

Clearance	Production	.0030-.0042 (0.0762-0.1066)	.0025-.0037 (0.0635-0.0939)	.0040-.0057 (0.1016-0.1447)
	Service	.005 (0.12) Max	.0075 (0.15) Max	.0065 (0.16)

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Gen V And Gen VI (Except 7.4L Gen VI) Engine Specifications

Unit of Measurement
In. (mm)

PISTON RING

ENGINE				7.4L	454 MAGNUM	502 MAGNUM 8.2L
Compression	Groove Side Clearance	Production	Top	.0012-.0029 (0.0305-0.0737)	.0017-.0032 (0.044-0.081)	.0017-.0032 (0.044-0.081)
			2nd	.0012-.0029 (0.0305-0.0737)	.0017-.0032 (0.044-0.081)	.0017-.0032 (0.044-0.081)
		Service		High Production Limit + .010 (0.02) Max		
	Gap	Production	Top	.010-.018 (0.25-0.46)		.011-.021 (0.28-0.53)
			2nd	.016-.024 (0.41-0.61)		.016-.026 (0.41-0.66)
		Service		High Limit Production + .010 (0.25) Max		
Oil	Groove Side Clearance	Production		.0050-.0065 (0.127-0.165)		
		Service		High Limit Production + .001 (0.25)		High Limit Production .005 (0.12) Max
	Gap	Production		.010-.030 (0.254-0.762)	.020-.035 (0.508-0.889)	.010-.030 (0.254-0.76)
		Service		High Limit Production + .001 (0.25)		High Limit Production .005 (0.12) Max

PISTON PIN

ENGINE		7.4L	454 MAGNUM	502 MAGNUM 8.2L
Diameter		.9895-.9897 (25.132-25.1371)	.9895-.9898 (25.134-24.140)	
Clearance In Pin	Production	.0002-.0007 (0.0050-0.0177)	.00025-.00035 (0.0064-0.0088)	
	Service	.001 (0.025) Max		
Fit In Rod		.0021-.0031 (0.0533-0.0787) Interference	.0008-.0016 (0.021-0.040) Interference	

Gen V And Gen VI (Except 7.4L Gen VI) Engine Specifications

Unit of Measurement In. (mm)

CRANKSHAFT

ENGINE			7.4L / 454 MAGNUM	502 MAGNUM / 8.2L
Main Journal	Diameter	No.1,2,3,4,5	2.7482-2.7489 (69.8042-69.8220)	
	Taper	Production	.0002 (0.005) Max	
		Service	.001 (0.02) Max	
	Out of Round	Production	.0002 (0.005) Max	
		Service	.001 (0.005) Max	
Main Bearing Clearance	Production	No.1,2,3,4	.0007-.0030 (0.043-0.076)	
		No.5	.0025-.0038 (0.063-0.096)	
	Service	No.1	.001-.003 (0.03-0.07)	.0010-.0015 (0.0254-0.0381)
		No.2,3,4	.001-.003 (0.03-0.07)	.0010-.0025 (0.0254-0.0635)
		No.5	.0025-.0040 (.0635-.1016)	
Crankshaft End Play			.006-.0010 (0.15-0.2)	
Connecting Rod Journal	Diameter		2.1990-2.1996 (55.8546-55.8698)	
	Taper	Production	.0005 (0.0127) Max	
		Service	.001 (0.0254) Max	
	Out of Round	Production	.0005 (0.0127) Max	
		Service	.001 (0.0254) Max	
Rod Bearing Clearance		Production	.0011-.0029 (0.028-0.074)	
		Service	.003 (0.076) Max	
Rod Side Clearance			.013-.023 (0.35-0.58)	
Crankshaft Runout @ No.3 Main Bearing			.0015 (0.038) Max	.0035 (0.088) Max

Gen V And Gen VI (Except 7.4L Gen VI) Engine Specifications

Unit of Measurement In. (mm)

VALVE SYSTEM

ENGINE MODEL			7.4L	454 MAGNUM	502 MAGNUM 8.2L
Lifter			Hydraulic		
Rocker Arm Ratio			1.70 to 1		
Face Angle (Intake & Exhaust)			45°		
Seat Angle (Intake & Exhaust)			46°		
Seat Runout (Intake & Exhaust)			.002(0.05) Max		
Seat Width		Intake	1/32-1/16 [.03125 .0625] in. (0.79-1.58 mm)		
		Exhaust	1/16-3/32 [.0625-.09375] in. (1.58-2.38 mm)		
Stem Clearance	Production	Intake	.0010-.0027 (0.025-0.069)		
		Exhaust	.0012-.0029 (0.0304-0.0736)		
	Service	Intake	.001 (0.02)	.003 (0.07)	.0037 (0.09)
		Exhaust	.002 (0.05)	.004 (0.10)	.0049 (0.12)
Stem Diameter		Intake	.372 (9.45)		
		Exhaust	.372 (9.45)		
Valve Margin (Intake and Exhaust)			.0312 (0.79)		
Valve Lash (Intake and Exhaust)			Fixed Lash		

Gen V And Gen VI (Except 7.4L Gen VI) Engine Specifications

Unit of Measurement In. (mm)

VALVE SPRING

ENGINE MODEL			7.4L	454 MAGNUM 502 MAGNUM 8.2L
Valve Spring (Note 1) (Note 2)	Free Length		2.12 (53.9)	2.15 (54.6)
	Pressure	Closed at 1.88 in. (47.8 mm)	Does Not Apply	110 Lbs. (489 N)
		Closed at 1.80 in. (45.7 mm)	74-86 Lbs. (329-382 N)	Does Not Apply
		Open at 1.34 in. (35.1 mm)	Does Not Apply	316 Lbs. (1406 N)
		Open at 1.40 in. (35.6 mm)	195-215 Lbs. (867-956 N)	Does Not Apply
	Installed Height		1.875 (47.6)	1.88 (47.7)
Damper or Damper Shield	Free Length		Does Not Apply	1.86 (47.2)
	Approximate Number Of Coils			4
Damper or Damper Shield	Valve Spring Fit in Damper Shield		.42-.094 (1.07-2.38) Interference	Does Not Apply

Note 1: 454/502/8.2L Models Only-Test spring pressure with inner and outer spring assembled.

Note 2: 7.4L Models Only Test spring pressure with damper shield installed.

Gen V And Gen VI (Except 7.4L Gen VI) Engine Specifications

Unit of Measurement In. (mm)

HYDRAULIC FLAT TAPPET CAMSHAFT

ENGINE MODEL		7.4L	454 MAGNUM 502 MAGNUM 8.2L
Lobe Lift ± .002 (0.051)	Exhaust	.271 (6.683)	.300 (7.62)
	Intake	.282 (7.163)	.300 (7.62)
Duration at .050 In. (1.27mm) Cam Lift	Exhaust	234°	224°
	Intake	238°	224°

ROLLER TAPPET CAMSHAFT

ENGINE MODEL		7.4L	454 MAGNUM 502 MAGNUM 8.2L
Lobe Lift ± .020 (0.051)	Exhaust	.284 (7.214)	.342 (8.687)
	Intake	.282 (7.163)	.342 (8.687)
Duration at .050 In.(1.27mm) Cam Lift	Exhaust	209°	227°
	Intake	209°	211°
Journal Diameter		1.9482-1.9492 (49.485-49.509)	
Journal Out Of Round		.001 (0.025) Max	
Camshaft Runout		.002 (0.051) Max	
Timing Chain Deflection		.375 (9.5) from taut position [total .75 (19)]	

FLYWHEEL

Runout	.008 (0.203) Max

CYLINDER HEAD

Gasket Surface Flatness	.007 (0.178) Overall Maximum .003 (0.076) within a 6 in. (152 mm) Span

7.4L Gen VI Engine Specifications

Unit of Measurement In. (mm)

Displacement	454 CID (7.4L)
Bore	4.25 (108)
Stroke	4.00 (101.6)
Compression Ratio	8.0:1
Heads	Cast Iron (Oval Port)
Intake Manifold	Cast Iron
Block	Cast Iron (4 Bolt Main Bearing Caps)
Rods	Forged Steel
Pistons	Cast Aluminum
Crankshaft	Cast Steel
Camshaft	Steel

CYLINDER BORE

Diameter			4.2500-4.2507 (107.950-107.968)
Out of Round		Production	.001 (0.025) Max
		Service	.002 (0.051) Max
Taper	Production	Thrust Side	.0005 (0.0120) Max
		Relief Side	.001 (0.0254) Max
	Service		.001 (0.0254) Over Production

PISTON

Clearance	Production	.0018-.0030 (0.0457-0.0762)
	Service	.0018 (0.0457) Max

7.4L Gen VI Engine Specifications

Unit of Measurement In. (mm)

PISTON RING

Compression	Groove Side Clearance	Production	2nd	.0012-.0029 (0.0304-0.0737)
		Service		High Production Limit + .010 (0.0254) Max
	Gap	Production	Top	.010-.018 (0.254-0.457)
			2nd	.016-.024 (0.406-0.6096)
		Service		High Limit Production + .010 (0.254) Max
Oil	Groove Side Clearance	Production		.0050-.0065 (0.1270-0.1651)
		Service		High Limit Production + .001 (0.254)
	Gap	Production		.010-.030 (0.254-0.762)
		Service		High Limit Production + .001 (0.254)

PISTON PIN

Diameter		.9895-.9897 (25.132-25.1371)
Clearance In Piston	Production	.0002-.0007 (0.0051-0.0177)
	Service	.001 (0.0254) Max
Fit In Rod		.0031-.0021 (0.0180-0.0787) Interference

7.4L Gen VI Engine Specifications

Unit of Measurement In. (mm)

CRANKSHAFT

Main Journal	Diameter	No. 1, 2, 3, 4, 5	2.7482-2.7489 (69.8040-69.8220)
	Taper	Production	.0004 (0.0102) Max
		Service	.001 (0.0254) Max
	Out of Round	Production	.0004 (0.0102) Max
		Service	.001 (0.0254) Max
Main Bearing Clearance	Production	No. 1	.0017-.0030 (0.043-0.076)
		No. 1, 2, 3, 4	.0011-.0024 (.0279-.0610)
	Production	No. 5	.0025-.0038 (0.0635-0.0965)
	Service	No. 1, 2, 3, 4	.0010-.0030 (0.0254-0.0762)
		No. 5	.0025-.0040 (.0635-.1016)
Crankshaft End Play			.005-.0011 (0.1270-0.2794)
Connecting Rod Journal	Diameter		2.1990-2.1996 (55.8546-55.8698)
	Taper	Production	.0005 (0.0127) Max
		Service	.001 (0.0254) Max
	Out of Round	Production	.0005 (0.0127) Max
		Service	.001 (0.0254) Max
Rod Bearing Clearance		Production	.0011-.0029 (0.0279-0.0736)
		Service	.001 (0.0254) Max
Rod Side Clearance			.013-.023 (0.330-0.5842)

7.4L Gen VI Engine Specifications

Unit of Measurement In. (mm)

VALVE SYSTEM

Lifter			Hydraulic Roller
Rocker Arm Ratio			1.70 to 1
Face Angle (Intake & Exhaust)			45°
Seat Angle (Intake & Exhaust)			46°
Seat Runout (Intake & Exhaust)			.002 (0.05) Max
Seat Width		Intake	.0300-.0600 (0.7620-1.5240)
		Exhaust	.0600-.0950 (1.5240-2.4130)
Stem Clearance	Production	Intake	.0010-.0029 (0.0254-0.0737)
		Exhaust	.0012-.0031 (0.0300-0.0787)
	Service	Intake	.0037 (0.0939)
		Exhaust	.0049 (0.1244)
Valve Lash (Intake and Exhaust)			Net Lash

VALVE SPRING

Valve Spring	Free Length		2.12 (53.9)
	Pressure	Closed	1.838 in. (46.6850 mm) at 71-79 Lbs. (316-351 N)
			Open 1.3470 in. (34.2130 mm) at 238-262 Lbs. (1059-1165N)
	Installed Height		1.8380 (46.6850) ± .07937 (47.6)

7.4L Gen Gen VI Engine Specifications

Unit of Measurement In. (mm)

FLYWHEEL

Runout	.008 (0.203) Max

CYLINDER HEAD

Gasket Surface Flatness	.004 (0.1016) Overall Maximum .003 (0.076) within a 6 in. (152mm) Span

Lobe Lift ± .020 (0.051)	Exhaust	.284 (7.214)
	Intake	.282 (7.163)
Duration at .050 In. (1.27mm) Cam Lift	Exhaust	209°
	Intake	209°
Journal Diameter		1.9482-1.9492 (49.485-49.509)
Journal Out Of Round		.001 (0.025) Max
Camshaft Runout		.002 (0.051) Max
Timing Chain Deflection		.375 (9.5) from taut position [total .75 (19)]

General

Some of the repairs in this section must be completed with engine removed from boat. Engine removal depends upon type of repair and boat design. Place engine on repair stand for major repairs.

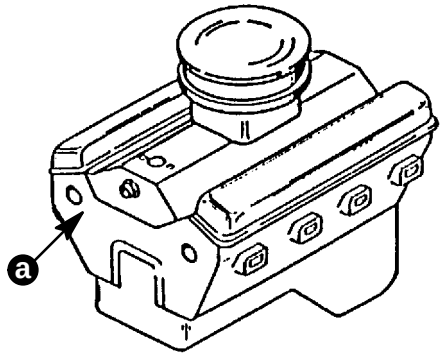
When engine removal is not required, make certain that battery cables are disconnected at the battery prior to performing any on-board repair procedures.

Lubricate all moving parts (during reassembly) with engine oil. Apply Quicksilver Perfect Seal on threads of and under heads of cylinder head bolts, and on threads of all cylinder block external bolts, screws and studs.

Engine Identification

The MerCruiser Model can be determined by looking at the last two letters of the engine code stamped into the cylinder block. This code number is stamped on all MerCruiser power packages and replacement partial engines, but not replacement cylinder block assemblies.

If the engine serial number and/or model decals are missing, the engine code letters may help in determining the engine models. Following is a list of GM engines and their respective code letters.



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a - Location Of GM Engine Code

MCM (Stern Drive)	Code	Rotation
7.4L	XW	LH
7.4L Bravo Three	UW,UB,XX	
7.4LX EFI Bravo	UJ	
7.4LX MPI Bravo	UC	
454 Magnum	XA	
454 Magnum MPI	UA	
502 Magnum	FJ	
502 Magnum MPI	FJ,HJ	

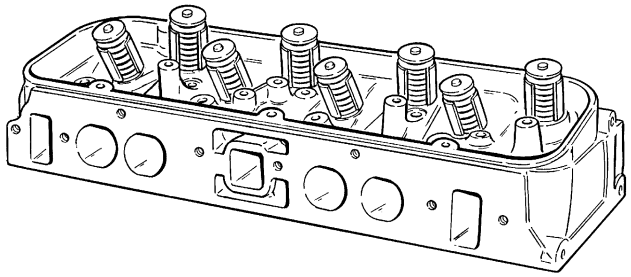
MIE (Inboard)	Code	Rotation
7.4L	XY	LH
7.4L EFI	UK	
7.4L MPI	UD	
8.2L	FH,HH	
454 EFI Ski	UA	

NOTE:*Engines with a 6 or 7 preceding the block code Gen VI engines. Example: 6XW would be a 7.4L Bravo.*

Cylinder Head Identification

7.4L

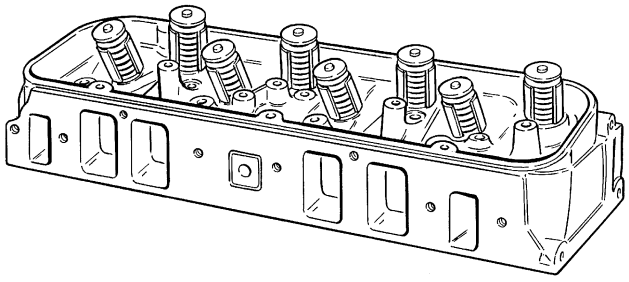
Gen V and VI Cylinder heads are identified by their smaller and rounded intake ports.



72913

454 MAGNUM / 502 MAGNUM / 8.2L

Mark IV cylinder heads are identified by “HI PERF” cast in the head under the rocker cover. Gen V and VI cylinder heads are by their large rectangular intake ports.



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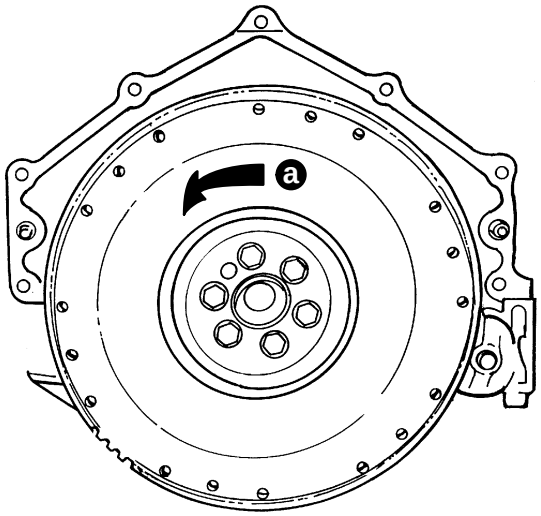
Engine Rotation

Engine rotation terminology at times has caused confusion. To clarify, engine rotation is determined by observing flywheel rotation from the rear (transmission or stern drive end) of the engine looking forward (water pump end).

PROPELLER ROTATION IS NOT NECESSARILY THE SAME as engine rotation.

When ordering replacement engines, short blocks or parts for engines, be certain to check engine rotation. Do not rely on propeller rotation in determining engine rotation.



a - Left-hand Rotation (CCW) - All Stern Drive (MCM) Engines And Inboard (MIE) (Standard) Rotation

Crankshaft

The crankshaft is supported in the block by five insert type bearings. Crankshaft end thrust is controlled by flanges on the No. 5 bearing. A torsional damper on the forward end of the crankshaft serves to help dampen any engine torsional vibration.

Piston and Connecting Rods

Piston pins are offset slightly toward the thrust side of the pistons to provide a gradual change in thrust pressure against the cylinder wall as the piston travels its path. Pins have a floating fit in the piston and a press fit in the connecting rod (to hold them in place).

Connecting rods are made of forged steel and are connected to the crankshaft through insert type bearings.

Camshaft and Drive

Flat tappet camshafts made of cast iron and roller lifter camshaft are made of steel. All camshafts are driven at one-half crankshaft speed by a timing chain and sprockets, or by timing gears, and are supported by five main bearings, which are pressed into the block.

A helical gear on the aft end of the camshaft drives the distributor and oil pump.

On engines with cast iron camshaft and flat faced lifters, a taper on the lobes, coupled with a spherical foot on the hydraulic valve lifters, causes the valve lifters to rotate, thus reducing wear.

Cylinder Head

The cylinder heads are made of cast iron and have individual intake and exhaust ports for each cylinder.

Stainless steel or graphite composition head gaskets are used to retard corrosion.

Valve Train

The valves and valve springs are of a heavy-duty design to withstand the high engine speeds encountered. Valve tips have been hardened to extend valve life. Exhaust valve rotators are used on some engines (7.4L only) to help extend valve life.

Hydraulic valve lifters ride directly on the camshaft lobes and transmit the thrust of the lobes to the push rods which in turn actuate the valves through the rocker arm.

In addition to transmitting thrust of the cam lobes, the hydraulic lifters also serve to remove any clearance (lash) from the valve train to keep all parts in constant contact.

The valve lifters also are used to lubricate the valve train bearing surfaces.

Intake Manifold

CARBURETED AND THROTTLE BODY INJECTION

The manifold is of the double level design for efficient fuel distribution. The upper level of passages feeds cylinders 2, 3, 5 and 8 while the lower level passages feed cylinders 1, 4, 6 and 7. All passages are of approximately equal length to assure more even fuel-air mixture to the cylinders.

MULTI-PORT INJECTION

The manifold is a cross flow design, with equal length runners. Injectors are positioned directly above the intake ports of each cylinder.

Lubrication System

The engine lubrication system is of the force-feed type in which oil is supplied under full pressure to the crankshaft, connecting rods, camshaft bearings and valve lifters, and is supplied under controlled volume to the push rods and rocker arms. All other moving parts are lubricated by gravity flow or splash.

A positive displacement gear-type oil pump is mounted on the rear main bearing cap and is driven by an extension shaft from the distributor (which is driven by the camshaft). Oil from the bottom of the pump in the rear of the oil pan is drawn into the oil pump through an oil pickup screen and pipe assembly.

If the screen should become clogged, a relief valve in the screen will open and continue to allow oil to be drawn into the system. Once the oil reaches the pump, the pump forces the oil through the lubrication system. A spring-loaded relief valve in the pump limits the maximum pump output pressure.

After leaving the pump, the pressurized oil flows through a full-flow oil filter. On engines with an engine oil cooler, the oil also flows through the cooler before returning to the block. A bypass valve allows oil to bypass the filter and oil cooler should they become restricted.

Some of the oil, after leaving the oil cooler and/or filter, is routed to the No. 5 crankshaft main bearing. The remainder of the oil is routed to the main oil gallery, which is located directly above the camshaft and runs the entire length of the block. From the main oil gallery, the oil is routed through individual oil passages to an annular groove in each camshaft bearing bore. Some of the oil is then used to lubricate camshaft bearings. The remainder of the oil is routed to the valve lifter oil galleries and No. 1, 2, 3, and 4 crankshaft main bearings by means of individual oil passages which intersect with the annular grooves.

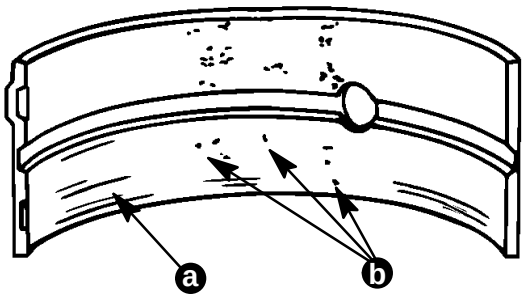
The camshaft bearings have holes which align with the oil passages or annular grooves in the block and allow oil to flow in-between the bearings and the camshaft journals. The oil that is forced out the front end of the No. 1 camshaft bearing drains down onto the camshaft drive and keeps it lubricated.

The oil which reaches the crankshaft main bearings is forced through a hole in the upper half of each bearing and flows in-between the bearings and the crankshaft journals. Some of the oil is then routed to the connecting rod bearings through grooves in the upper half of the crankshaft main bearings and oil passages in the crankshaft. Oil which is forced out the ends of the connecting rod bearings and crankshaft main bearings is splashed onto the camshaft, cylinder walls, pistons and piston pins, keeping them lubricated. Oil which is forced out the front end of the No. 1 crankshaft main bearing also assists in lubricating the camshaft drive. A baffle plate, mounted on the bottom of the main bearings or in the oil pan, prevents oil thrown from the crankshaft and connecting rods from aerating the oil in the oil pan.

Oil which reaches the valve lifter oil galleries is forced into each hydraulic valve lifter through holes in the side of the lifter. From here, the oil is forced through the metering valve in each of the lifters (which controls the volume of oil flow) and then up through the push rods to the rocker arms. A hole in each rocker arm push rod seat allows the oil to pass through the rocker arm and lubricate the valve train bearing surfaces. After lubricating the valve train, oil drains back to the oil pan through oil return holes in the cylinder head and block.

The distributor shaft and gear also is lubricated by the oil flowing through the right valve lifter oil gallery.

Bearing Failures



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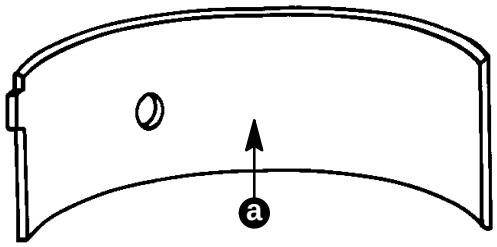
Scratched By Dirt

a - Scratches
b - Dirt Imbedded In Bearing Material



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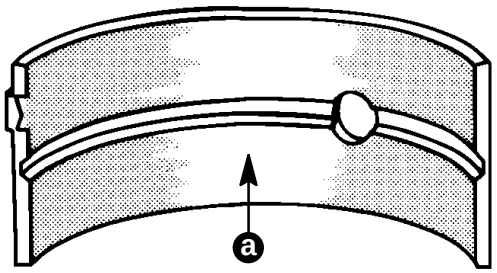
Tapered Journal

a - Overlay Gone From Entire Surface



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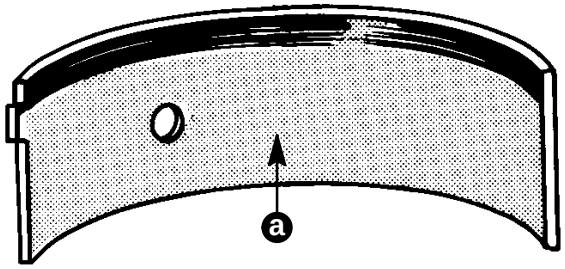
Lack Of Oil

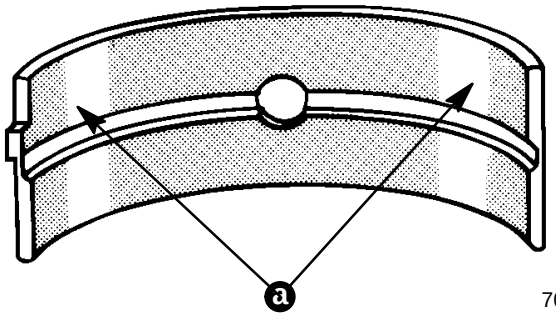
a - Overlay Worn Off



70436

Radius Ride

a - Worn Area



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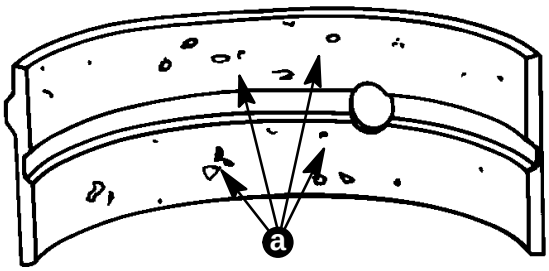
Improper Seating

a - Bright Or Polished Sections



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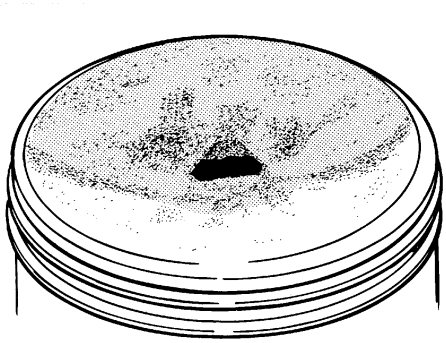
Fatigue Failure

a - Craters or Pockets

Piston Failures

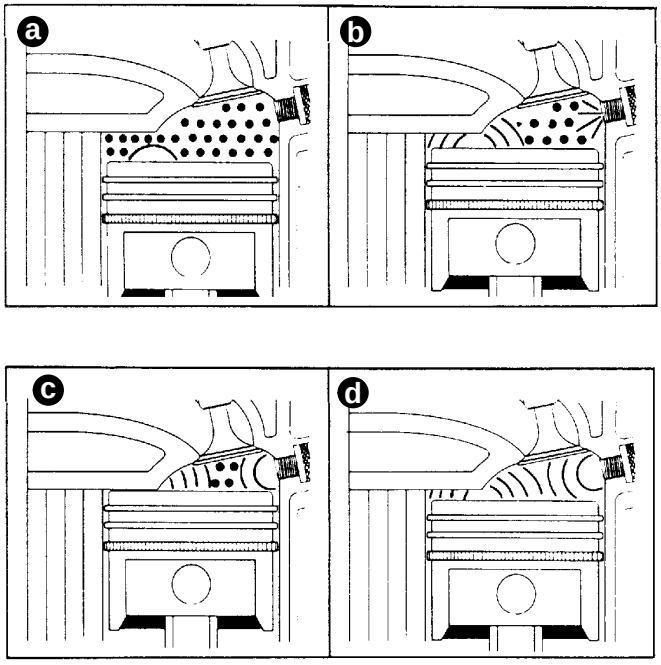
Pre-Ignition

Pre-ignition is abnormal fuel ignition, caused by combustion chamber hot spots. Control of the start of ignition is lost, as combustion pressure rises too early, causing power loss and rough running. The upward motion on the piston is opposed by the pressure rise. This can result in extensive damage to the internal parts from the high increase in combustion chamber temperature.



72424

Pre-Ignition Damage



72314

a - Ignited By Hot Deposits
b - Regular Ignition Spark
c - ignites Remaining Fuel
d - Flame Front Collide

PRE-IGNITION CAUSES

1. Hot spots in the combustion chamber from glowing deposits (due in turn to the use of improper oils and/or fuels).
2. Overheated spark plug electrodes (improper heat range or defective plug).
3. Any other protuberance in the combustion chamber, such as an overhanging piece of gasket, an improperly seated valve or any other inadequately cooled section of material which can serve as a source.

Engine failures, which result from the foregoing conditions, are beyond the control of Mercury Marine; therefore, no warranty will apply to failures which occur under these conditions.

Detonation

Detonation, commonly called “fuel knock,” “spark knock” or “carbon knock,” is abnormal combustion of the fuel which causes the fuel to explode violently. The explosion, in turn, causes overheating or damage to the spark plugs, pistons, valves and, in severe cases, results in pre-ignition.

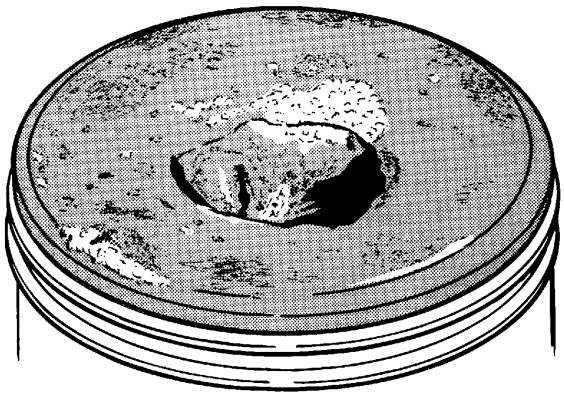
Use of low octane gasoline is one of the most common causes of detonation. Even with high octane gasoline, detonation could occur if engine maintenance is neglected.

OTHER CAUSES OF DETONATION

IMPORTANT: Use of improper fuels will cause engine damage and poor performance.

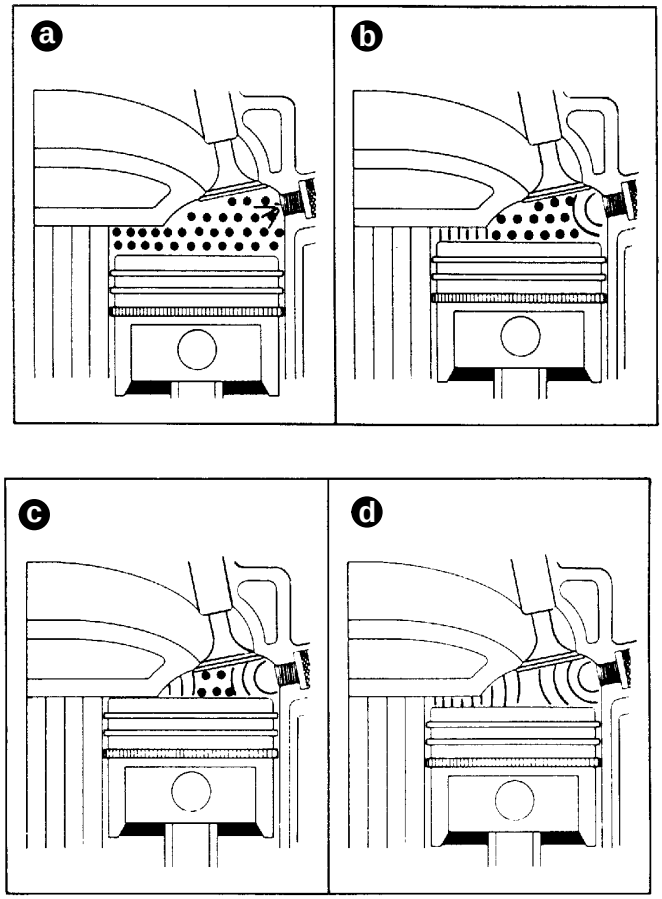
1. Over-advanced ignition timing.
2. Lean fuel mixture at or near full throttle (could be caused by carburetor or leaking intake manifold).
3. Cross-firing spark plugs.
4. Excess accumulation of deposits on piston and/or combustion chamber (results in higher compression ratio).
5. Inadequate cooling of engine by deterioration of cooling system.

NOTE:*Engine failures, which result from the foregoing conditions, are beyond the control of MerCruiser; therefore, no warranty will apply to failures which occur under these conditions.*



72425

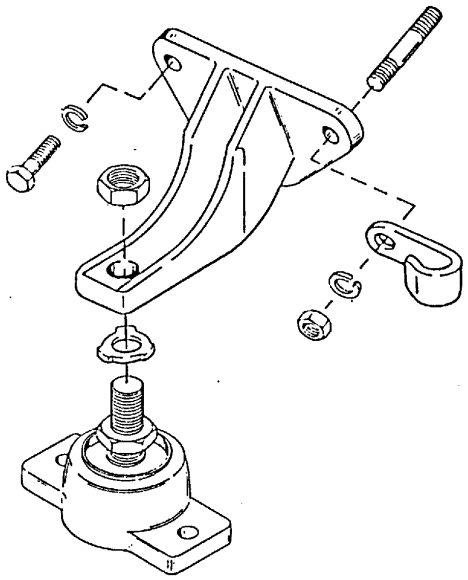
Detonation Damage



72315

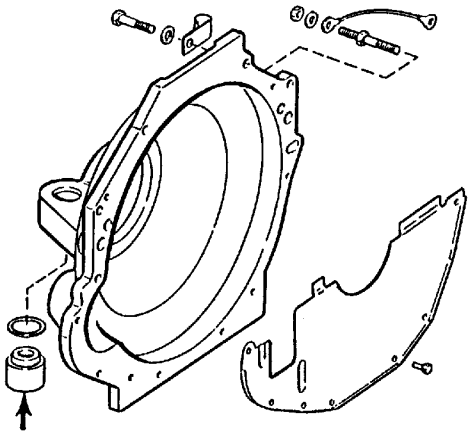
a - Spark Occurs
b - Combustion Begins
c - Combustion Continues
d - Detonation Occurs

Engine Mounts



72317

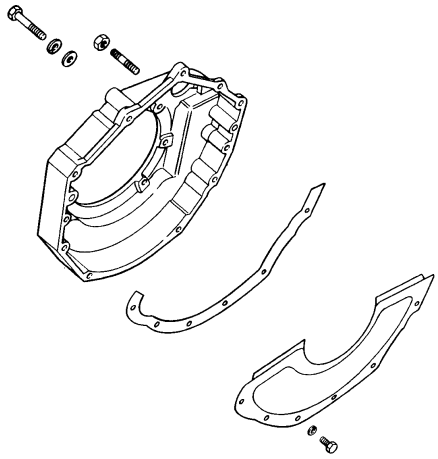
Front Mount - All MCM (Stern Drive) Models



72318

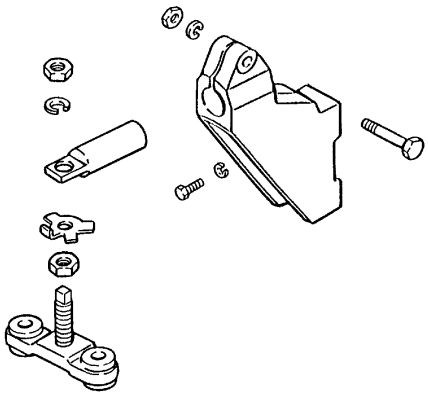
Rear Mount/Flywheel Housing - All MCM (Stern Drive) Models

Engine Mounts (Continued)



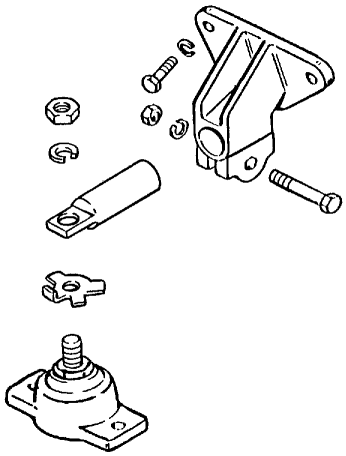
73055

Flywheel Housing - All MIE (Inboard) Models



73056

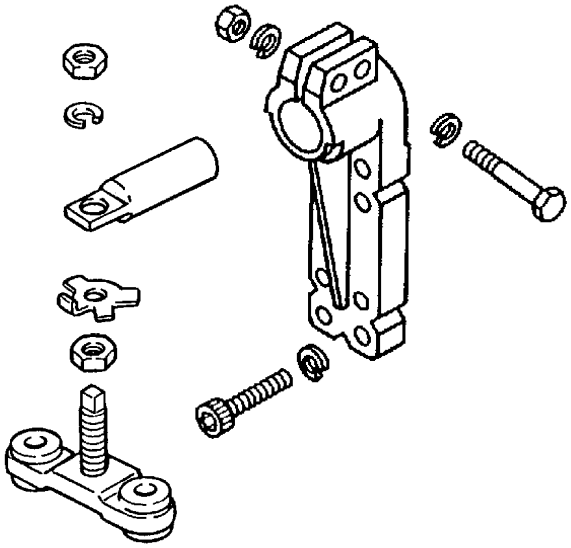
Rear Mount Assembly - MIE 7.4L/8.2L with Borg-Warner In-Line Transmission



72319

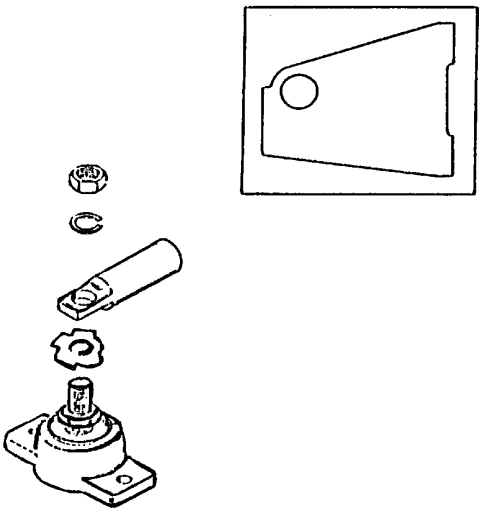
Front Mount Assembly - All MIE Models

a - Rubber Insert Cannot Be Removed



71789

Rear Mount Assembly - MIE 7.4L/8.2L with Hurth Down Angle and V-Drive Transmission



72319

Rear Mount Assembly - MIE 7.4L with Borg-Warner Remote V-Drive Transmission

a - Rubber Insert Cannot Be Removed

Rocker Arm Cover

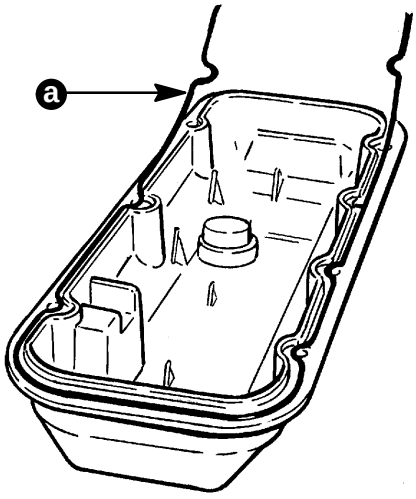
Removal

On Engines with Center Exhaust Outlet Exhaust Manifolds: It may be necessary to remove exhaust manifold before removing rocker arm cover. Refer to Section 7B for removal. Also remove any component that will interfere with the removal of the manifold.

1. Disconnect crankcase ventilation hoses.
2. Remove any items that interfere with the removal of rocker arm covers.
3. Remove rocker arm cover.

Installation

1. Clean sealing surfaces on cylinder head and rocker arm cover with degreaser.
2. Place new rocker arm cover gasket in position in rocker arm cover.



72928

a - Rocker Arm Cover Gasket

3. Install rocker arm cover. Torque bolts to 70 lb. in. (10 N·m).
4. Reinstall exhaust manifolds, if removed.
5. Reinstall any items which were removed to allow removal of rocker arm covers.
6. Connect crankcase ventilation hoses to rocker arm covers.
7. Start engine and check for oil leaks.

Intake Manifold

NOTICE

For repair procedures on Fuel Injection Engines, refer to Section 5C.

Removal

1. Drain engine cooling system.
2. Disconnect hoses from thermostat housing.
3. Disconnect intake manifold-to-circulating pump by-pass hose from circulating pump.
4. Disconnect electrical leads interfering with removal.
5. Disconnect crankcase ventilation hoses from rocker arm covers.
6. Disconnect throttle cable from carburetor. Remove fuel line and sight tube running between fuel pump and carburetor.
7. Remove distributor cap and mark position of rotor on distributor housing. Also, mark position of distributor housing on intake manifold. Remove distributor.

IMPORTANT: Do not crank engine over after distributor has been removed.

8. Remove other ignition components.
9. Disconnect any other miscellaneous items that will prevent removal of manifold.

IMPORTANT: It may be necessary to pry intake manifold away from cylinder heads and block, in next step. Use extreme care to prevent damage to sealing surfaces.

10. Remove intake manifold bolts, then remove intake manifold and carburetor assembly.

NOTE:*If intake manifold requires replacement, transfer all remaining parts to new manifold.*

Cleaning and Inspection

1. Clean gasket material from all mating surfaces.

IMPORTANT: When cleaning cylinder head mating surface, do not allow gasket material to enter engine crankcase or intake ports.

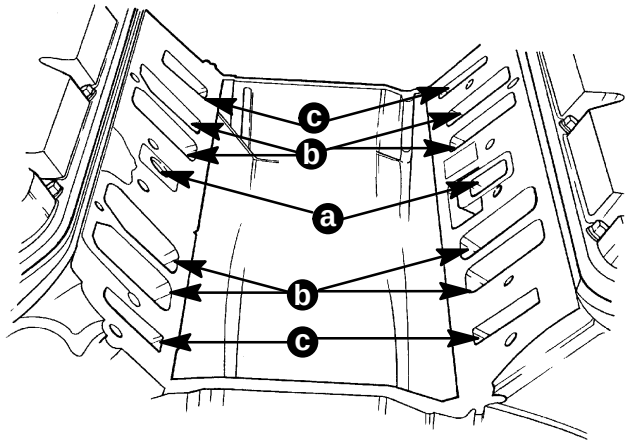
2. Inspect manifold for cracks or scratches. Machined surfaces must be clean and free of all marks and deep scratches or leaks may result.
3. Check intake passages for varnish buildup and other foreign material. Clean as necessary.

Installation

IMPORTANT: When installing intake manifold gaskets, in next step, be sure to do the following:

- **Be sure to install gasket with marked side up. Both gaskets are identical.**
- **All MerCruiser V-8 GM engines that have "automatic" carburetor chokes must use an intake gasket that has an opening for the exhaust crossover port in the intake manifold. Without this opening the "automatic" carburetor choke will not operate properly. The choke will remain ON longer causing rough engine operation and wasted fuel.**

1. Apply Quicksilver Perfect Seal to intake manifold gaskets around coolant passages (both sides).



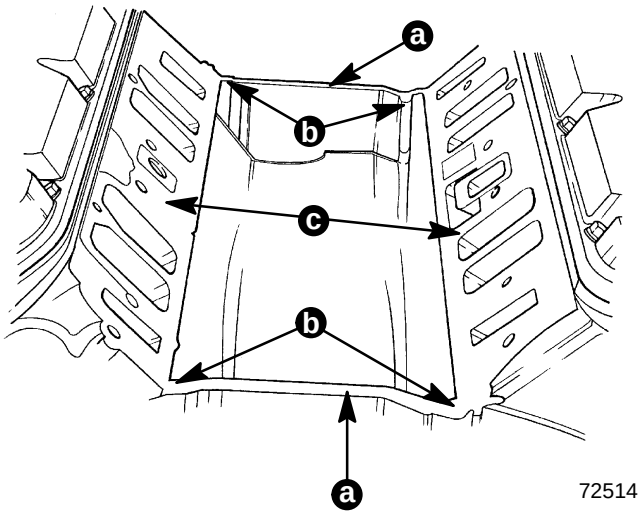
72514

a - Exhaust Crossover Port Opening in Gasket
b - Intake Valve Port
c - Coolant Passages

⚠ WARNING

Be sure to read and follow package label directions when using bellows adhesive.

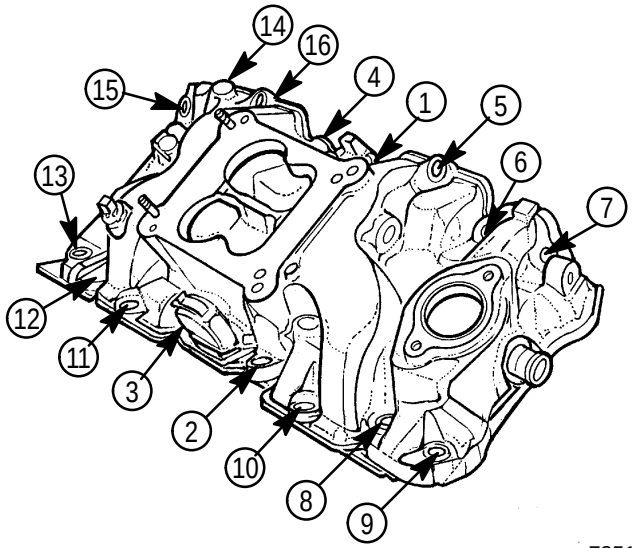
2. Using Quicksilver Bellows Adhesive, glue neoprene gaskets to engine block between cylinder heads.
3. Apply a small amount of RTV Sealer on neoprene gasket ends.
4. Set intake manifold gaskets in place, aligning bolt holes.



72514

a - Neoprene Gaskets
b - RTV Sealer
c - Gaskets

5. Carefully install manifold assembly. On all engines except 7.4L / 454 / 502 Magnum Multi-Port Injection, torque bolts to 35 lb. ft. (48 N·m) in sequence as shown.



72515

Intake Manifold Torque Sequence

6. Connect all electrical leads.
7. Connect hoses to thermostat housing.
8. Install fuel line and sight tube to carburetor and fuel pump.
9. Connect crankcase ventilation hoses to rocker arm covers. Reconnect throttle cable to carburetor.
10. Install distributor. Position rotor and housing to align with marks made during removal, then install distributor cap.
11. Install other ignition components and reconnect wires.
12. Connect any other items which were disconnected from manifold during removal.
13. Start engine. Adjust ignition timing and carburetor. Check hose connections, gaskets and seals for leaks.
14. Inspect fuel line connections for fuel leaks.

Rocker Arm / Push Rod

Removal

NOTE:*When servicing only one cylinder's rocker arms, bring that cylinder's piston up to TDC before removing rocker arms. When servicing all rocker arms, bring No. 1 piston up to TDC before removing rocker arms.*

1. Remove rocker arm covers as outlined.
2. Remove rocker arm assemblies and push rods.

IMPORTANT: Place rocker arm assemblies and push rods in a rack for reassembly in their original locations.

Cleaning and Inspection

1. Clean parts with solvent and dry with compressed air.
2. Inspect all contact surfaces for wear. Replace all damaged parts.

Installation

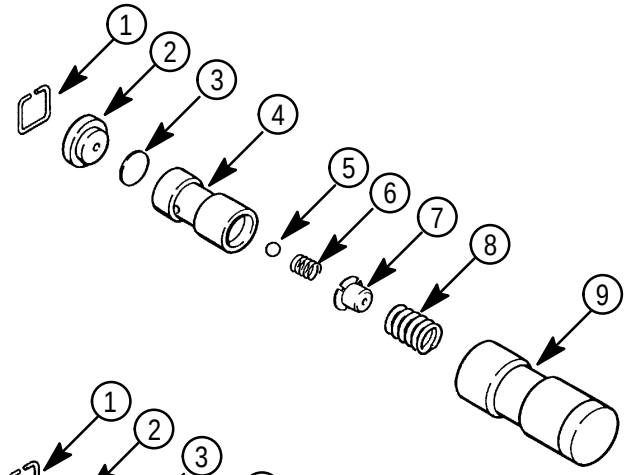
IMPORTANT: When installing rocker arms and rocker arm balls, coat bearing surfaces of rocker arms and rocker arm balls with engine oil.

1. Install push rods in their original locations. Be sure push rods seat in lifter socket.
2. Install rocker arms, rocker arm balls and rocker arm bolts in their original locations. Torque to specification.

Valve Adjustment

No adjustment is required. Valve lash is automatically set when rocker arm bolts are torqued to 45 lb. ft. (61 N·m).

Hydraulic Valve Lifters (Flat and Roller Lifter)



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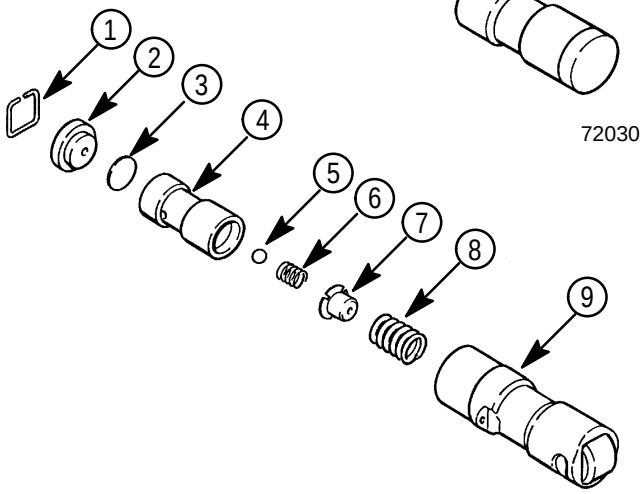


72031

1 - Push Rod Seat Retainer
2 - Push Rod Seat
3 - Metering Valve
4 - Plunger
5 - Check Ball
6 - Check Ball Spring
7 - Check Ball Retainer
8 - Plunger Spring
9 - Lifter Body

Index

Hydraulic valve lifters require little attention. Lifters are extremely simple in design. Normally, readjustments are not necessary and servicing requires only that care and cleanliness be exercised in the handling of parts.

Locating Noisy Lifters

Locate a noisy valve lifter by using a piece of garden hose approximately 4 ft. (1.2 m) in length. Place one end of hose near end of each intake and exhaust valve, with other end of hose to the ear. In this manner, sound is localized, making it easy to determine which lifter is at fault.

Another method is to place a finger on face of valve spring retainer. If lifter is not functioning properly, a distinct shock will be felt when valve returns to its seat.

General types of valve lifter noise are as follows:

1. Hard rapping noise - usually caused by plunger becoming tight in bore of lifter body so that return spring cannot push plunger back up to working position. Probable causes are:
   a. Excessive varnish or carbon deposit, causing abnormal stickiness.
   b. Galling or “pickup” between plunger and bore of lifter body, usually caused by an abrasive piece of dirt or metal wedged between plunger and lifter body.
2. Moderate rapping noise - probable causes are:
   a. Excessively high leakdown rate.
   b. Leaky check valve seat.
   c. Improper adjustment.
3. General noise throughout valve train - this will, in most cases, be a definite indication of insufficient oil supply or improper adjustment.
4. Intermittent clicking - probable causes are:
   a. A microscopic piece of dirt momentarily caught between ball seat and check valve ball.
   b. In rare cases, ball itself may be out of round or have a flat spot.
   c. Improper adjustment.

In most cases, where noise exists in one or more lifters, all lifter units should be removed, disassembled, cleaned in solvent, reassembled and reinstalled in engine. If dirt, corrosion, carbon, etc., is shown to exist in one unit, it more likely exists in all the units; thus it would only be a matter of time before all lifters caused trouble.

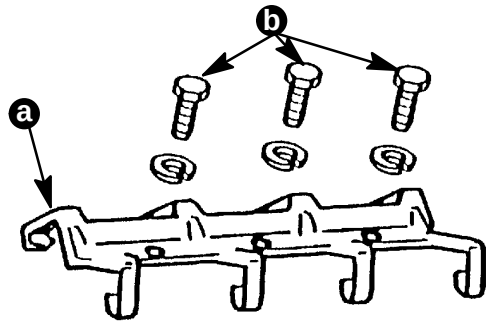
Removal

IMPORTANT: Keep push rod and hydraulic valve lifter from each valve together as a matched set and mark them so they can be reinstalled in the same location later.

Remove as outlined:

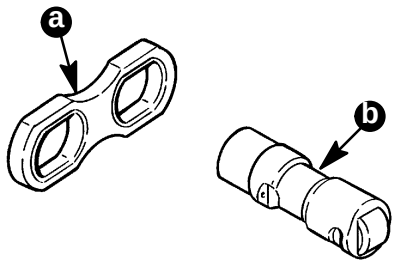
1. Remove rocker arm covers.
2. Remove intake manifold.
3. Remove rocker arm assemblies and push rods.
4. Remove valve lifters.

NOTE:*Gen VI engines with roller lifters have additional valve train components shown below.*



72329

a - Lifter Restrictor Retainer
b - Fasteners



72340

a - Roller Lifter Restrictor
b - Roller Lifter

5. Remove lifter restrictors on roller lifters models.
6. Remove valve lifters.

Installation

IMPORTANT: It is recommended that the engine oil be changed and a new oil filter be installed whenever servicing valve lifters or camshaft.

IMPORTANT: Before installing lifters, coat the bottom of the lifter with engine oil. If new lifters or a new camshaft have been installed, an additive containing EP lube (such as General Motors Cam and Lifter Pre-lube or equivalent) should be poured over camshaft lobes before installing lifters.

IMPORTANT: Before installation, coat entire valve lifter with engine oil.

IMPORTANT: DO NOT install used valve lifters if a new camshaft has been installed.

1. Install hydraulic valve lifters and components.
2. Install intake manifold.
3. Install push rods and rocker arms. Torque rocker arm bolts to specification.
4. Install rocker arm cover.
5. Start engine and check for leaks.

Valve Stem Oil Seal/Valve Spring

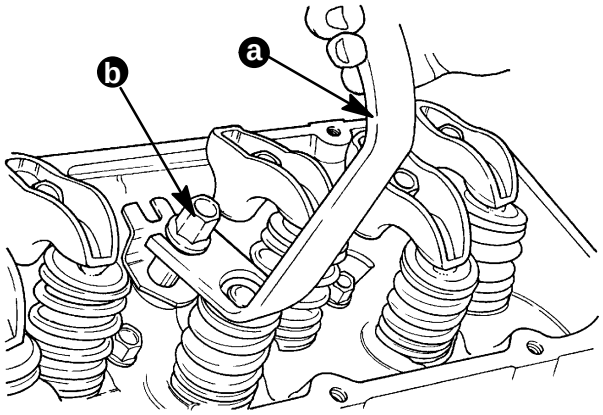
Removal - Head Installed

1. Remove:
   a. Rocker arm cover.
   b. Spark plug of affected cylinder.
   c. Rocker arm assembly.
2. Install air line adaptor tool (J-23590) in spark plug hole and apply compressed air to hold valves in place.

NOTE:*If compressed air is not available, piston may be brought up to TDC and used to keep valves from falling out of valve guides.*

IMPORTANT: Do not turn crankshaft while valve springs, retainers, and locks are removed or valves will fall into cylinder.

3. Using valve spring compressor as shown, compress valve spring and remove valve locks.



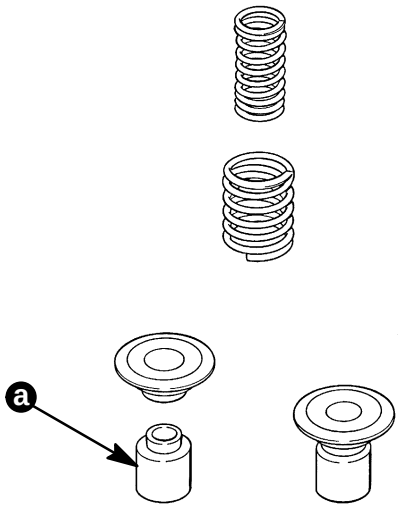
72516

a - Valve Spring Compressor (J-5892)
b - Rocker Arm Nut

4. Slowly release valve spring compressor. Remove cap, shield, and valve spring.

IMPORTANT: Keep air pressure in cylinder while springs, caps, and valve locks are removed or valves will fall into cylinder.

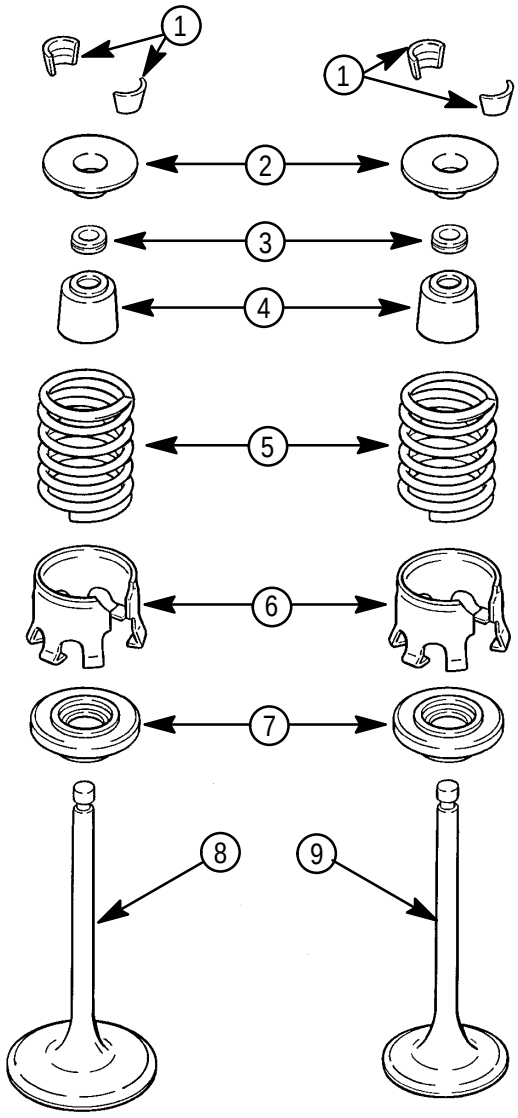
5. Remove oil shields from valve stems.



72149

a - Valve Stem Oil Shield

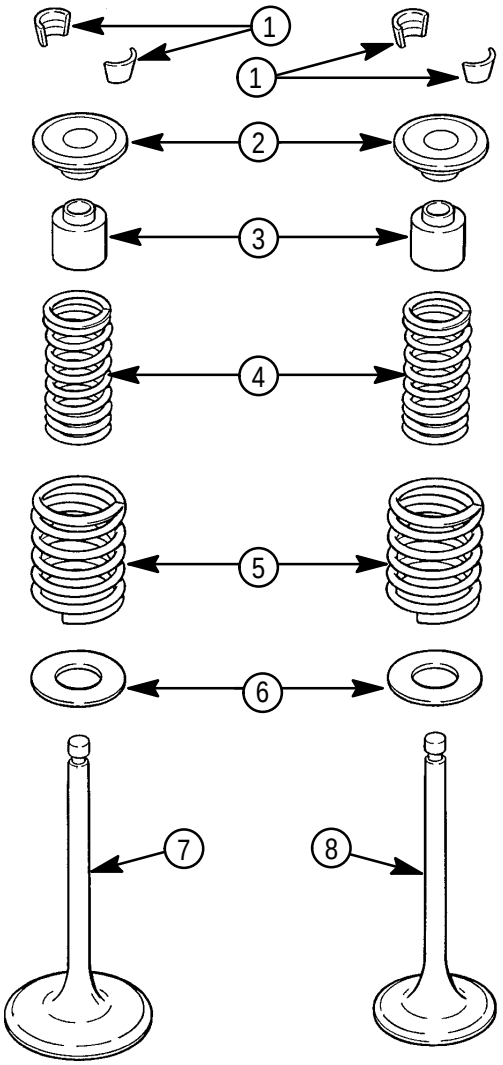
Valve Assembly (Exploded View)



72279

7.4L Only

1 - Valve Lock
2 - Retainer
3 - Oil Shield Seal
4 - Oil Shield
5 - Outer Spring
6 - Damper Shield
7 - Rotator
8 - Intake Valve
9 - Exhaust Valve



72278

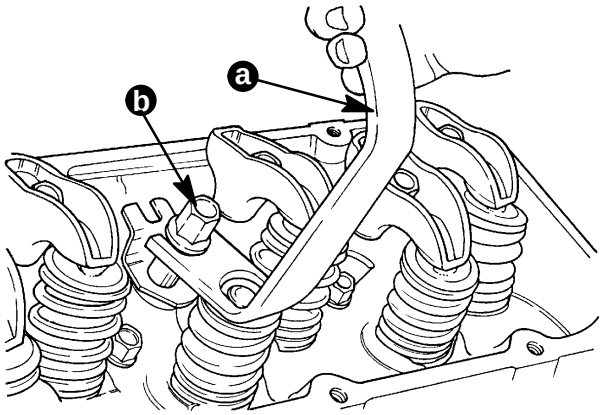
454 Magnum / 502 Magnum/ 8.2L

1 - Valve Lock
2 - Retainer
3 - Oil Shield
4 - Inner Spring
5 - Outer Spring
6 - Shim
7 - Intake Valve
8 - Exhaust Valve

Installation - Head Installed

7.4L

1. Place rotator or shim on valve spring seat.
2. Coat valve stem and new seal with engine oil. Install seal over valve stem.
3. If taken apart, reassemble damper and valve spring. Place on top of rotator or shim.
4. Set valve spring assembly and cap in position over valve stem.
5. Compress spring, using valve spring compressor, and install valve locks (grease may be used to hold valve locks in place). Slowly release tool, making sure valve locks seat properly in valve stem grooves.



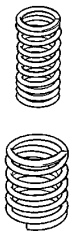
72516

a - Valve Spring Compressor (J-5892)
b - Rocker Arm Nut

6. Install push rods and rocker arm assemblies. Torque to specifications.
7. Install rocker arm cover [torque to 90 in. ft. (10 N·m)] and spark plug [torque to 22 lb. ft. (30 N·m)].

454 MAGNUM / 502 MAGNUM / 8.2L

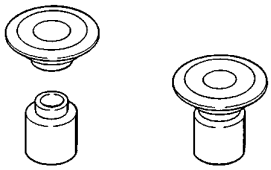
1. Place shim on valve spring seat.
2. If taken apart, reassemble damper and valve spring as shown. Make sure tighter wound coils of spring and damper are on the same end.



72149

3. Place valve spring assembly in position with tighter wound coils against spring seat.

IMPORTANT: Valve seal and cap must be assembled as shown before installation.



72149

4. Coat valve stem and new seal with engine oil.
5. Set cap and seal assembly on valve stem. Align valve stem with center of valve seal.
6. Compress valve spring, using valve spring compressor, and install valve locks (grease may be used to hold valve locks in place). Slowly release tool to prevent damaging seal. Make sure valve locks seat properly in valve stem grooves.
7. Install push rods and rocker arm assemblies. Torque to specifications.
8. Install rocker arm cover [torque to 90 in. ft. (10 N·m)] and spark plug [torque to 22 lb. ft. (30 N·m)].

Cylinder Head

Removal

1. Drain engine cooling system.
2. Remove as outlined:
   a. Exhaust manifolds.
   b. Intake manifold.
   c. Rocker arm covers.
   d. Rocker arm assemblies and push rods (keep in order for reassembly in their original locations).
   e. Any components attached to front or rear of cylinder head.
   f. Spark plugs.
   g. Head bolts.

⚠CAUTION

The head gasket may be holding cylinder head to block. Use care when prying off cylinder heads. DO NOT damage gasket surfaces. DO NOT drop cylinder heads.

3. Place cylinder head on wooden blocks to prevent damage to gasket surfaces.

Cleaning and Inspection

1. Clean gasket material and sealer from engine block and cylinder heads.
2. Inspect sealing surfaces for deep nicks and scratches.
3. Inspect for corrosion around cooling passages.
4. Clean head bolt threads and engine block bolt hole threads, making sure no dirt, old oil or coolant remain.

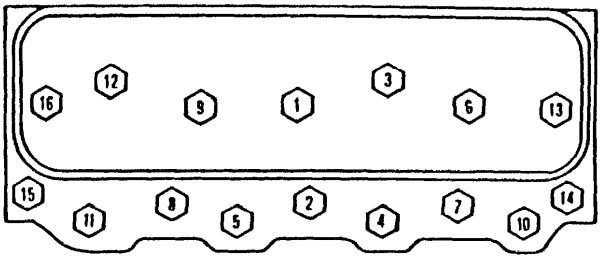
Installation

⚠CAUTION

DO NOT use sealer on head gaskets.

1. Place head gasket in position over dowel pins.
2. Carefully set cylinder head in place over dowel pins.
3. Coat threads of head bolts with Quicksilver Perfect Seal and install finger-tight.
4. To insure gasket sealing, torque head bolts in three steps, following torque sequence for each step. Start first step at 20 lb. ft. (27 N·m), second step at 50 lb. ft. (68 N·m), and finish with a final torque of

7.4L	85 lb. ft. (115 N·m)
454/502 Magnum	92 lb. ft. (124 N·m)



72944

Cylinder Head Torque Sequence

5. Install push rods and rocker arm assemblies in their original positions. Coat threads on rocker arm bolt with Perfect Seal. Torque

7.4L	40 lb. ft. (54 N·m)
454/502 Magnum	45 lb. ft. (61 N·m)

6. Install as outlined:
   a. Intake manifold.
   b. Rocker arm covers.
   c. Exhaust manifolds.
   d. Spark plugs.
   e. Any components removed from front or rear of cylinder heads.

7. Follow procedures in Section 6A or 6B of this manual:

   Seawater Cooled Models: Provide for adequate water supply to seawater pickup (see Section 6A).

   Closed Cooled Models: Refill closed cooling section (see Section 6B), and provide adequate water supply to seawater pickup.

⚠CAUTION

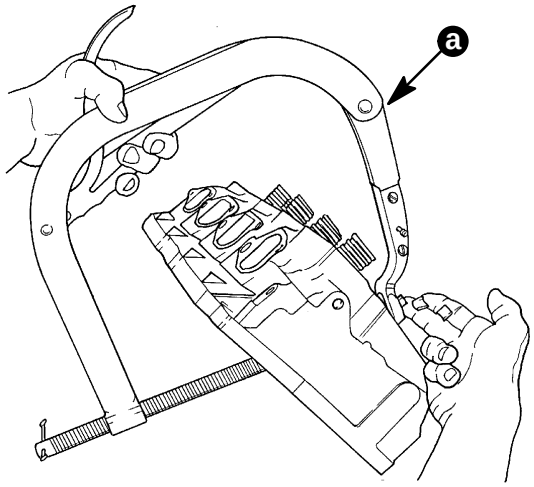
Ensure that cooling water supply is available before starting the engine.

8. Start engine, set timing, set idle speed, and check for leaks.

Cylinder Head and Valve Conditioning

Disassembly

1. Using valve spring compressor, compress valve spring and remove valve locks. Slowly release tool.



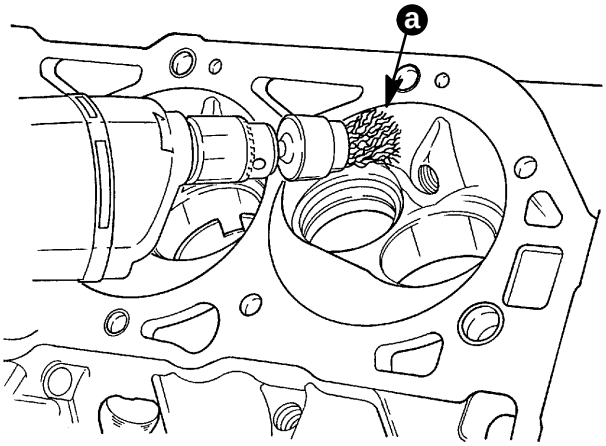
72565

a - Valve Spring Compressor (J-8062)

2. Remove all valve components.
3. Remove valves from cylinder head and place in a rack, in order, for reassembly in their original locations.

Cleaning

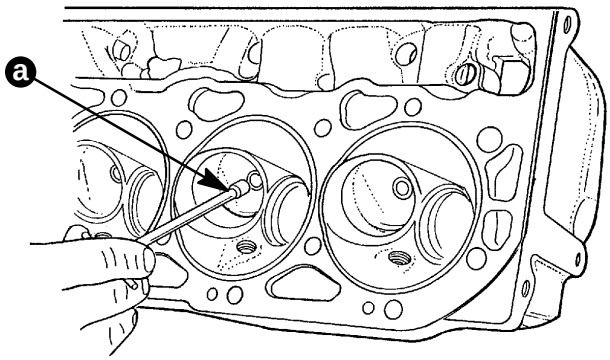
1. Clean push rods and rocker arm assemblies.
2. Clean carbon from valves using a wire wheel.
3. Clean gasket material from cylinder head mating surfaces.
4. Clean all carbon from combustion chambers and valve ports using carbon remover brush.



72567

a - Carbon Remover Brush (J-8089)

5. Thoroughly clean valve guides with valve guide cleaner.

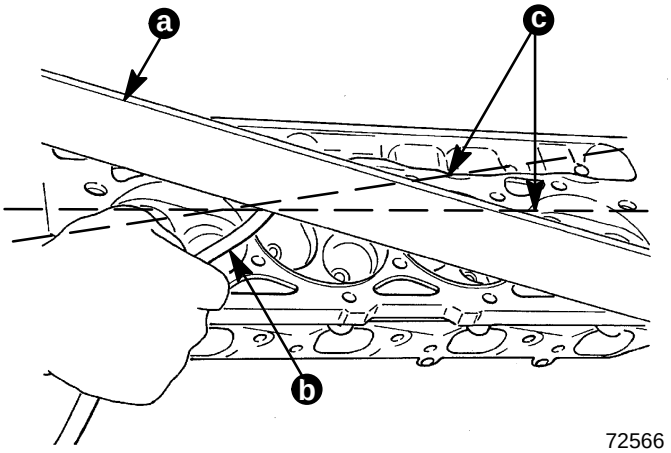


72564

a - Valve Guide Cleaner (J-8101)

Inspection

1. Inspect cylinder heads for cracks in exhaust ports, water jackets, and combustion chambers (especially around spark plug holes and valve seats). Replace heads if any cracks are found.
2. Inspect cylinder head gasket surface for burrs, nicks, or erosion or other damage. Also, check flatness of cylinder head gasket surface, using a machinist's straight edge and feeler gauges as shown. Refer to "Specifications."



72566

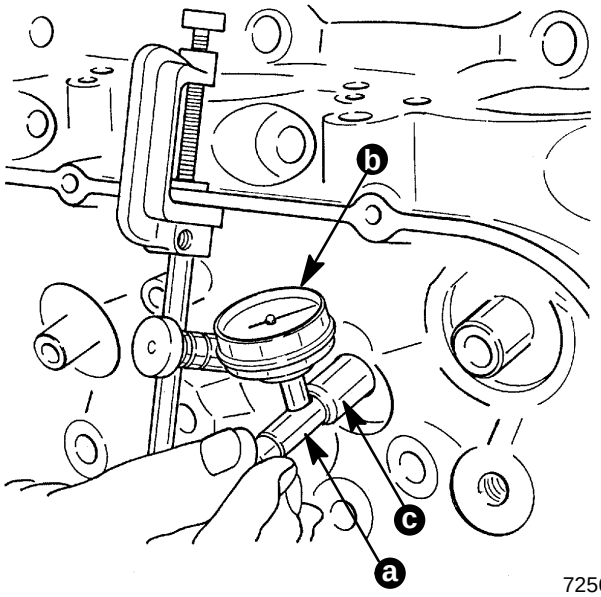
a - Straight Edge
b - Feeler Gauge
c - Take Both Measurements Diagonally Across Head (Both Ways) And Straight Down Center Of The Head

IMPORTANT: Cylinder head-to-block gasket surface should be resurfaced if warped more than specified. When head resurfacing is required, cylinder head-to-intake manifold gasket surface on head must be milled to provide proper alignment between intake manifold and head.

3. Inspect valves for burned heads, cracked faces or damaged stems.
4. Inspect rocker arm bolts and push rod guides for wear and damage.

IMPORTANT: Excessive valve stem to bore clearance will cause excessive oil consumption and possible valve breakage. Insufficient clearance will result in noisy and sticky valves.

5. Measure valve stem clearance as follows:
   a. Attach a dial indicator to cylinder head, positioning it against the valve stem and close to the valve guide.
   b. Holding valve head off seat about 1/16 in. (2 mm), move valve stem back and forth in direction shown. Compare stem clearance with specifications.



72563

a - Valve Stem
b - Dial Indicator
c - Valve Guide

   c. If clearance exceeds specifications, it will be necessary to ream valve guides for oversized valves, as outlined under "Valve Guide Bore Repair."

Valve Guide Bore Repair

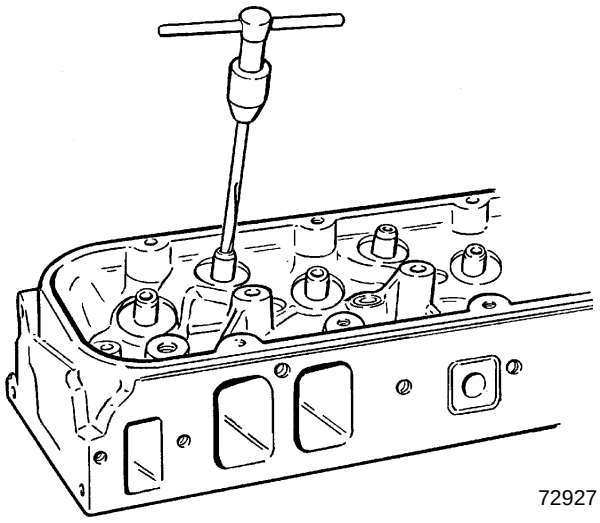
IMPORTANT: Be sure to measure valve stem diameter of both the intake and exhaust valve, as valve stem diameter may or may not be the same for both valves.

If .015 in. oversize valves are required, ream valve guide bores for oversize valves, as follows:

1. Measure valve stem diameter of old valve being replaced and select proper size valve guide reamer from chart below.

Standard Valve Stem Diameter	Reamer Required For .015 In. Oversize Valve
.372 In.	J-7049

2. Ream valve guide bores, as shown.



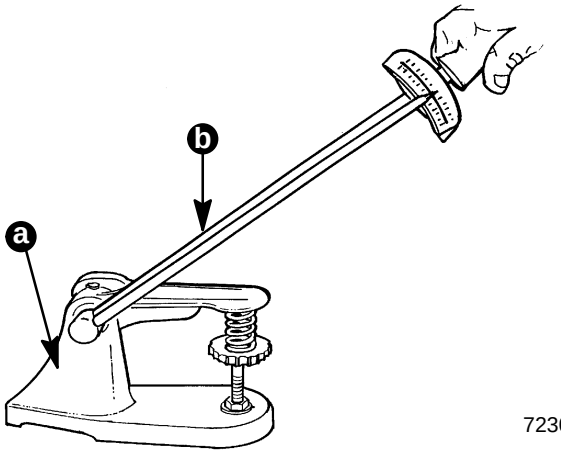
72927

3. Remove the sharp corner created by reamer at top of valve guide.

Valve Springs - Checking Tension

NOTE:*On 7.4L models, spring tension must be tested with damper removed. All other models require testing with dampers installed. Refer to "Specifications."*

IMPORTANT: Springs should be replaced if not within 10 lb. (44 N) of specified tension.



72308

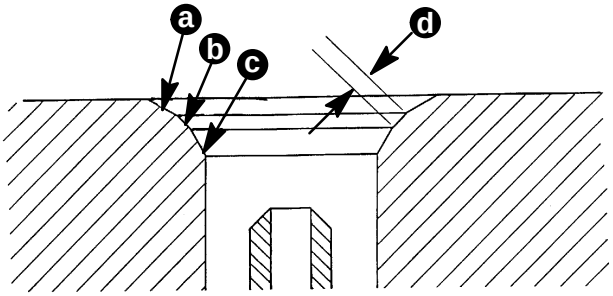
a - Valve Spring Tester (J-8056)
b - Torque Wrench

Valve Seat Repair

Valve seat reconditioning is very important, since seating of valves must be perfect for engine to deliver maximum power and performance.

Another important factor is valve head cooling. Good contact between each valve and its seat in head is important to ensure that heat in valve head will be properly dispersed.

Several different types of equipment are available for reseating valve seats. Equipment manufacturer's recommendations should be followed carefully to attain proper results.

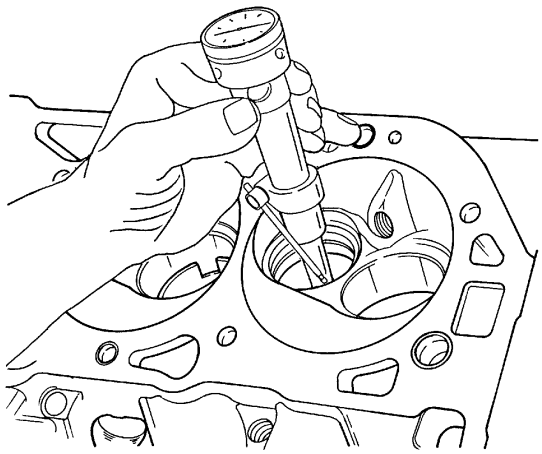


50668

Typical "3 Angle" Valve Seat

a - Top Angle (30°)
b - Seat Angle (46°)
c - Bottom Angle (60°)
d - Seat Width
IIntake - .060-.090 in (1.52-2.29 mm)
Exhaust - .060-.090 in (1.52-2.29 mm)

Regardless of type of equipment, however, it is essential that valve guide bores be free from carbon or dirt to achieve proper centering of pilot in valve guide, ensuring concentricity.



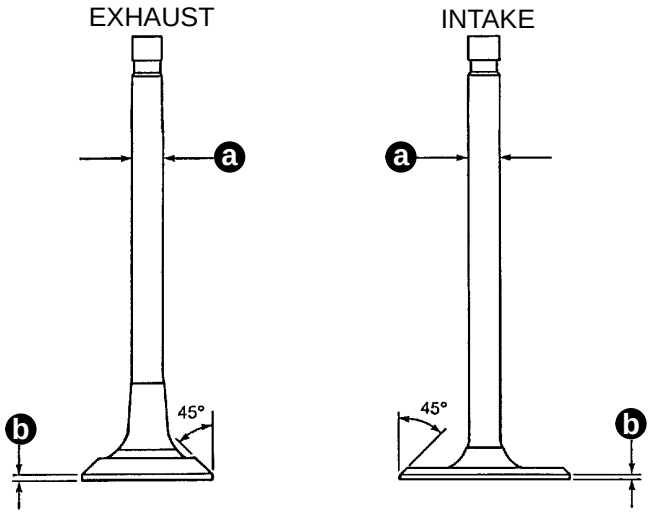
72568

Measuring Valve Seat Concentricity

Valve Grinding

Valves that are pitted must be refaced to the proper angle. Valve stems which show excessive wear, or valves that are warped excessively, must be replaced. When a valve head which is warped excessively is refaced, a knife edge will be ground on part or all of the valve head, due to the amount of metal that must be removed to completely reface. Knife edges lead to breakage, burning, or pre-ignition due to heat localizing on this knife edge. If the edge of the valve head is less than 1/32 in. (0.8 mm) after grinding, replace the valve.

Several different types of equipment are available for refacing valves. The recommendation of the manufacturer of the equipment being used should be carefully followed to attain proper results.



50695

Exhaust

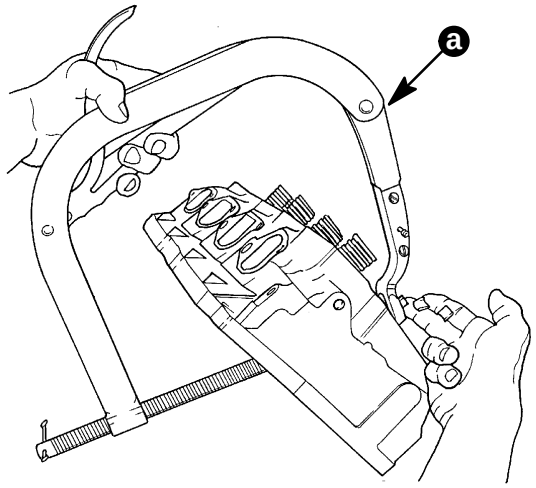
a - 372 In. (9.45 mm)
b - 1/32 [.031] In. (0.79 mm) Min.

Intake

a - 372 In. (9.45 mm)
b - 1/32 [.031] In. (0.79 mm) Min.

Reassembly

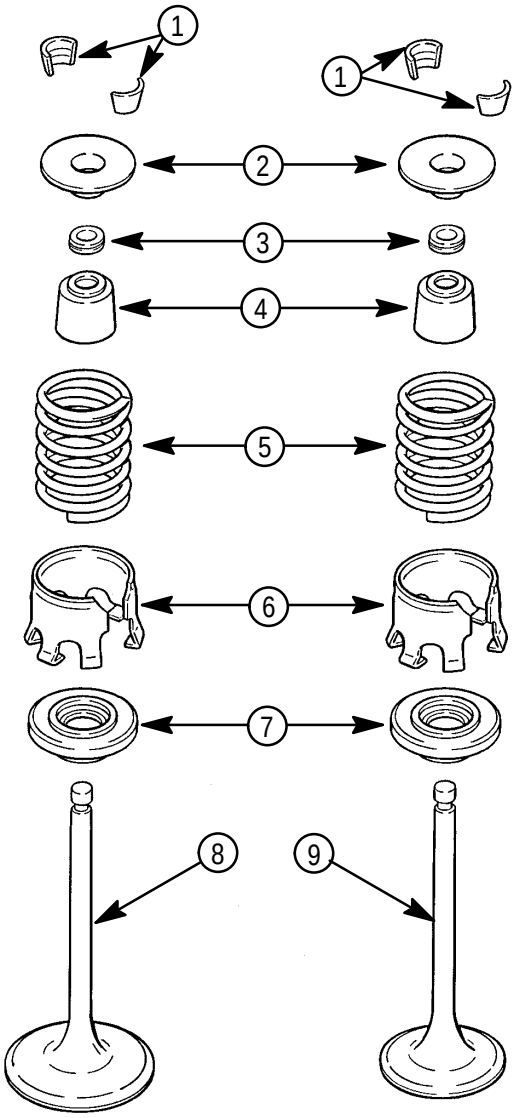
1. Lubricate valve guides and valve stems with engine oil.
2. Install each valve in the port from which it was removed or to which it was fitted.
3. Install valve rotators, shims, springs, seals, and caps as shown under “Valve Assembly (Exploded View)” for each particular engine.
4. Using valve spring compressor, compress valve spring and install valve locks (grease may be used to hold locks in place).



72565

a - Valve Spring Compressor (J-8062)

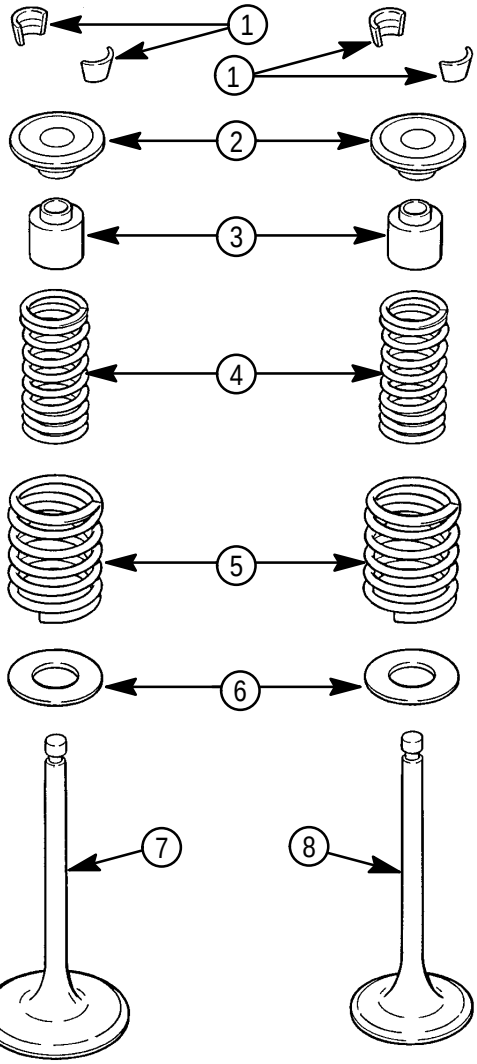
5. Slowly release tool, making sure valve locks seat properly in grooves of valve stem.



72279

7.4L

1 - Valve Lock
2 - Retainer
3 - Oil Shield
4 - Oil Shield Seal
5 - Outer Spring
6 - Damper Shield
7 - Rotator
8 - Intake Valve
9 - Exhaust Valve

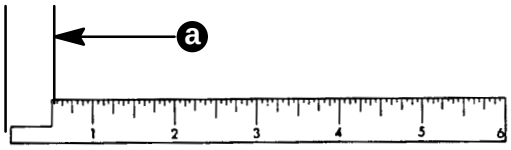


72278

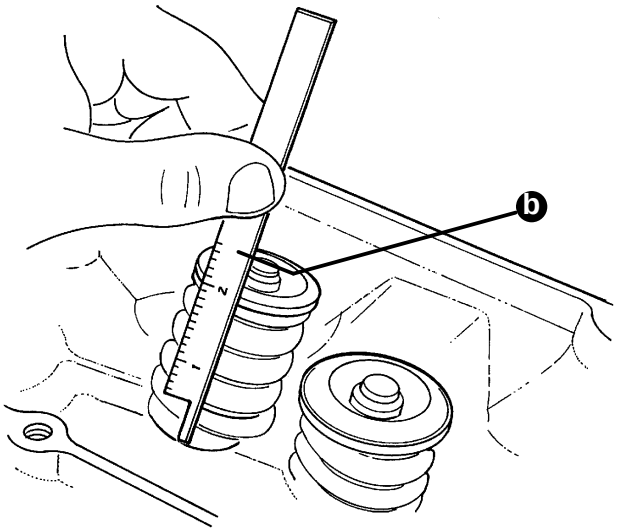
454 Magnum / 502 Magnum / 8.2L

a - Valve Lock
b - Retainer
c - Oil Shield
d - Inner Spring
e - Outer Spring
f - Shim
g - Intake Valve
h - Exhaust Valve

6. Check installed height of valve springs using a narrow, thin scale cutaway as shown. Measure from spring seat to top of valve spring, as shown. If measurement exceeds specified height, install a valve spring shim and recheck. DO NOT shim valve springs to give an installed height less than the minimum specified.



50037



72562

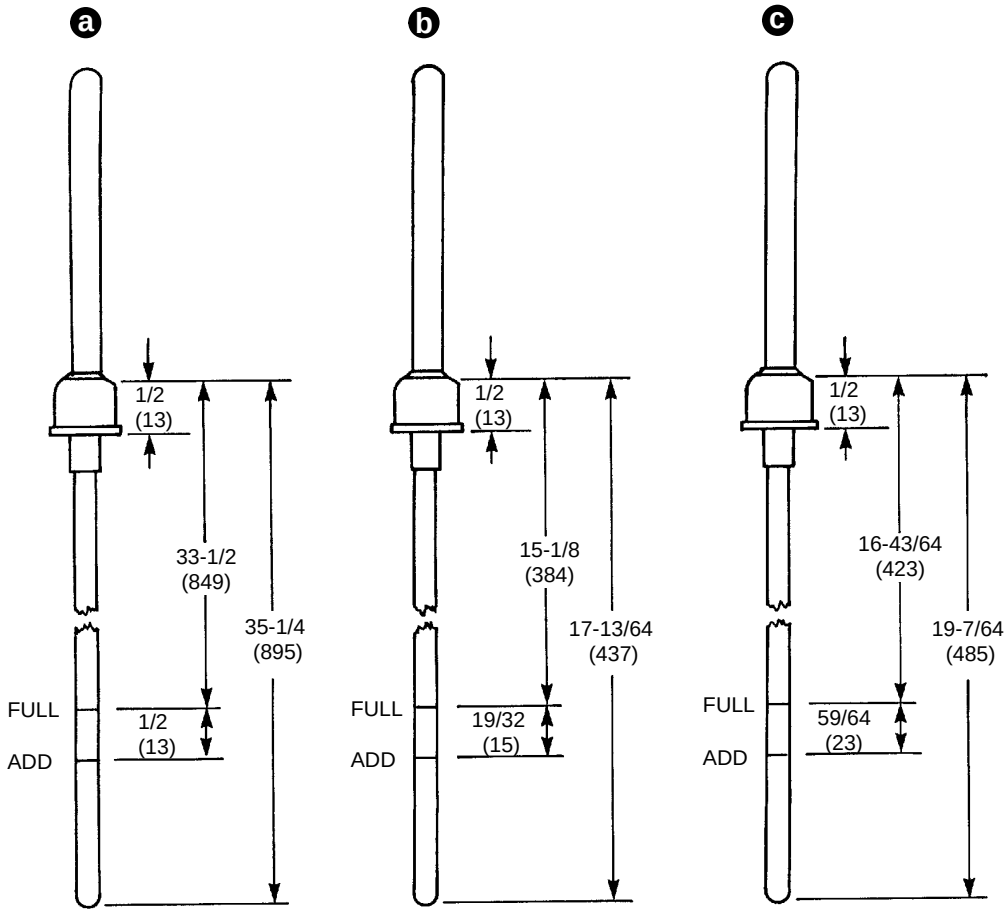
Cutaway Scale

a - Cut Away This Portion (1/2 Inch)
b - Valve Spring Installed Height

Dipstick Specifications

All Engines

UNIT OF MEASUREMENT In. (mm)



72341

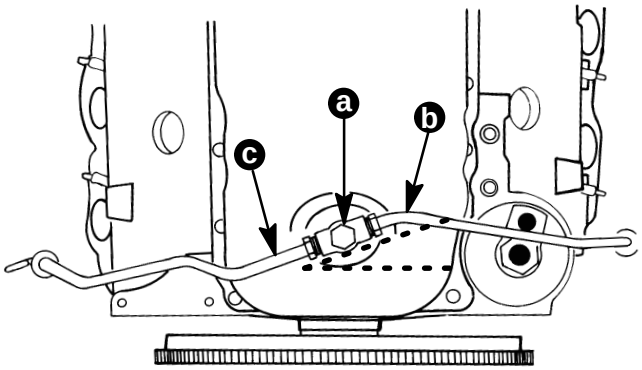
a - MCM Engines (805567)
b - MIE Velvet Drive In Line Transmissions (821503-3)
c - MIE All Transmissions Except Velvet Drive (821503-4)

Oil Pan

Removal

1. Drain crankcase oil.
2. Remove dipstick and tube, or tubes, if equipped with two. Note shape of port and starboard tubes as shown following to aid in reassembly. On High Output (H.O.) Engine only, disconnect outlet hose of seawater pump.

IMPORTANT: On Generation V engines DO NOT move or disturb the orientation of fitting on bottom of pan or incorrect oil level readings may be obtained.



71308

Generation V MIE Engine Oil Pan

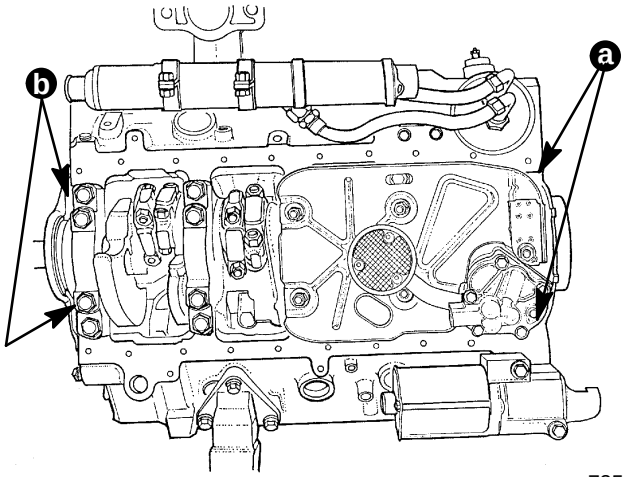
a - Factory Positioned Fitting For Tubes (Do Not Move)
b - Port Tube
c - Starboard Tube

3. Remove oil pan.

Installation

1. Clean sealing surfaces of engine block and oil pan.
2. Apply a small amount of Quicksilver RTV Sealer to joints of rear seal retainer and joints of front cover.

IMPORTANT: Quicksilver RTV Sealer sets up in about 15 minutes. Be sure to complete assembly promptly.

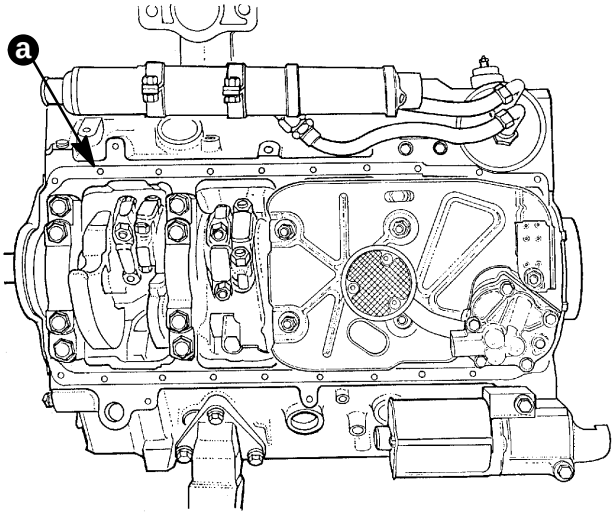


72544

a - Joints Of Rear Seal Retainer
b - Joints Of Front Cover

3. Install oil pan gasket in position as shown.

NOTE:*A one-piece oil pan gasket may be re-used if it is still pliable and is not cracked, torn or otherwise damaged.*

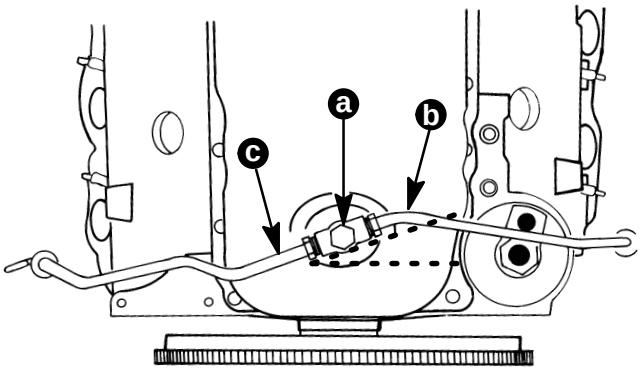


72545

a - Oil Pan Gasket

4. Install oil pan. Starting from the center and working outward in each direction, tighten 5/16-18 threaded fasteners to 165 lb. in. (19 N·m).
5. Install dipstick tube(s) and dipstick(s). Be certain, if equipped with two tubes, that they are fitted where they were removed, and positioned as shown following.

IMPORTANT: DO NOT move or disturb the orientation of fitting on bottom of pan or incorrect oil level readings may be obtained.



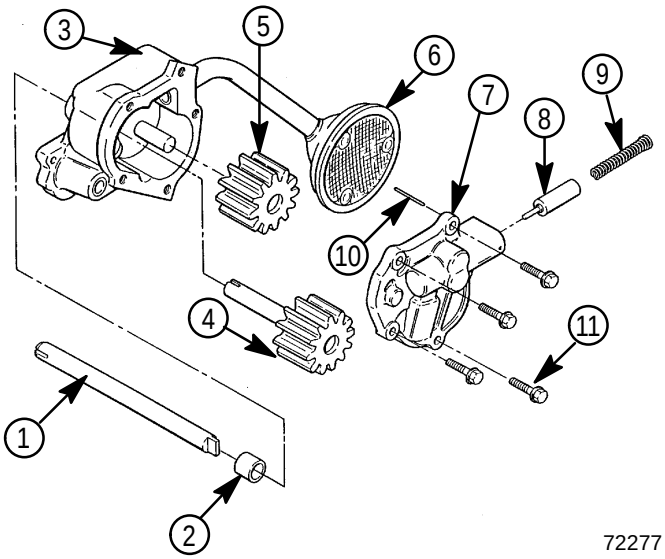
71308

Generation V MIE Engine Oil Pan

a - Factory Positioned Fitting For Tubes (Do Not Move)
b - Port Tube
c - Starboard Tube

6. Fill crankcase with required quantity of oil of specified viscosity. See Section 1B - “Maintenance.”

Oil Pump



72277

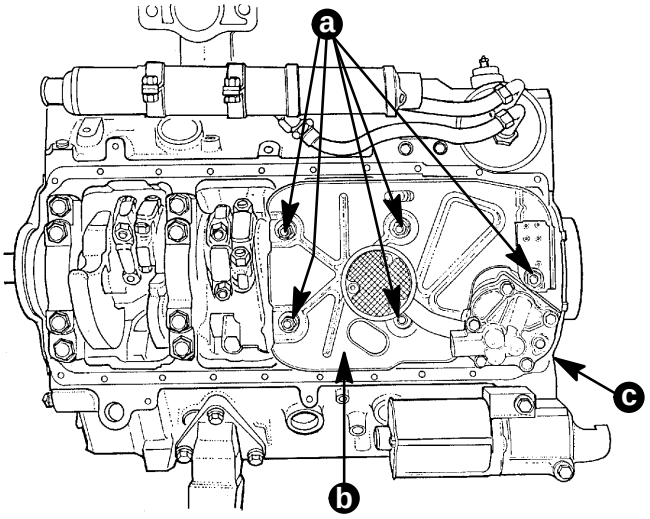
Oil Pump Assembly

1 - Extension Shaft
2 - Shaft Coupling
3 - Pump Body
4 - Drive Gear and Shaft
5 - Idler Gear
6 - Pickup Screen and Pipe
7 - Pump Cover
8 - Pressure Regulator Valve
9 - Pressure Regulator Spring
10- Retaining Pin
11- Screws

The oil pump consists of two gears and a pressure regulator valve enclosed in a two-piece housing. Oil pump is driven by distributor shaft which is driven by a helical gear on camshaft.

Removal

1. Remove oil pan as outlined.
2. Remove gasket carefully as the one-piece gasket for the oil pan may be reused if still pliable and not cracked, torn, etc.
3. Remove baffle.



72545

a - Nuts (5)
b - Baffle
c - Oil Pump

4. Remove oil pump.

Disassembly

1. Remove pump cover.

IMPORTANT: Mark gear teeth for reassembly with same teeth indexing.

2. Remove idler gear and drive gear from pump body.
3. Remove retaining pin, spring, and pressure regulator valve from pump cover.

Cleaning and Inspection

1. Wash all parts in cleaning solvent and dry with compressed air.
2. Inspect pump body and cover for cracks or excessive wear.
3. Inspect pump gears for damage and excessive wear.
4. Check for loose drive gear shaft in pump body.
5. Inspect inside of pump cover for wear that would permit oil to leak past ends of gears.
6. Inspect pickup screen and pipe assembly for damage to screen and pipe.
7. Check pressure regulator valve for fit.

IMPORTANT: Oil pump is not serviceable. If any parts are worn or damaged, replacement of entire pump assembly and pickup tube is necessary.

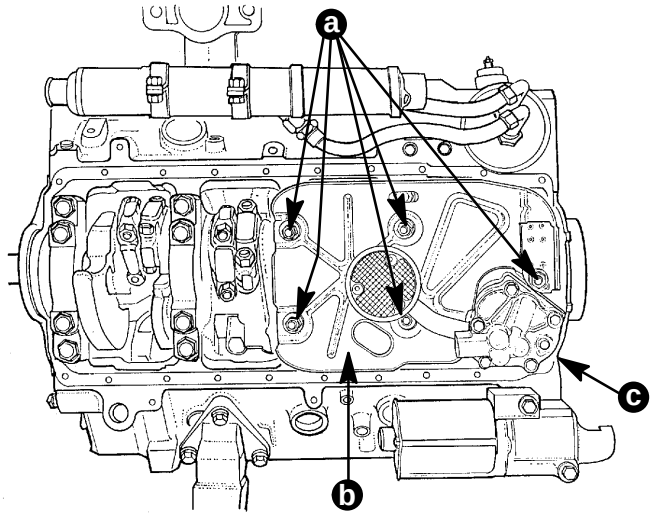
Reassembly

IMPORTANT: Oil internal parts liberally before installation.

1. Install pressure regulator valve and related parts.
2. Install drive gear in pump body.
3. Install idler gear in pump body with smooth side of gear toward pump cover opening. Align marks made in disassembly.
4. Fill gear cavity with engine oil.
5. Install pump cover and torque attaching screws to 80 lb. in. (9 N·m).
6. Turn extension shaft by hand to check for smooth operation.

Installation

1. Install pump, with extension shaft, to rear main bearing, aligning extension shaft with distributor drive shaft.
2. Install baffle. Tighten baffle nuts to 25 lb. ft. (34 N·m). Tighten oil pump bolt to 70 lb. ft. (95 N·m).



72545

a - Nuts (5)
b - Baffle
c - Oil Pump

3. Install oil pan as outlined. The one-piece gasket for the oil pan may be reused if still pliable and not cracked, torn, etc.

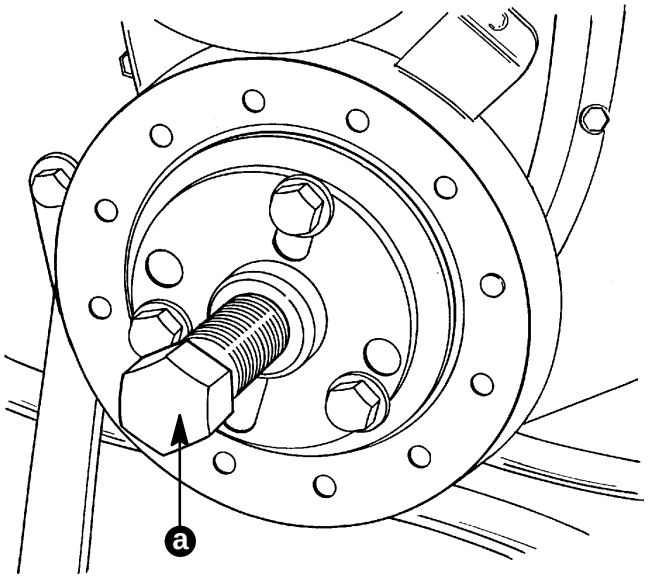
Torsional Damper

Removal

1. Remove drive belts.
2. Remove drive pulley and water pump pulley, then remove torsional damper retaining bolt.

IMPORTANT: Do not use a universal claw type puller to remove torsional damper (in next step) as outside ring of torsional damper is bonded in rubber to the hub and use of claw type puller may break the bond.

3. Remove torsional damper with Torsional Damper Remover and Installer.



72345

a - Torsional Damper Remover and Installer (J-23523-E)

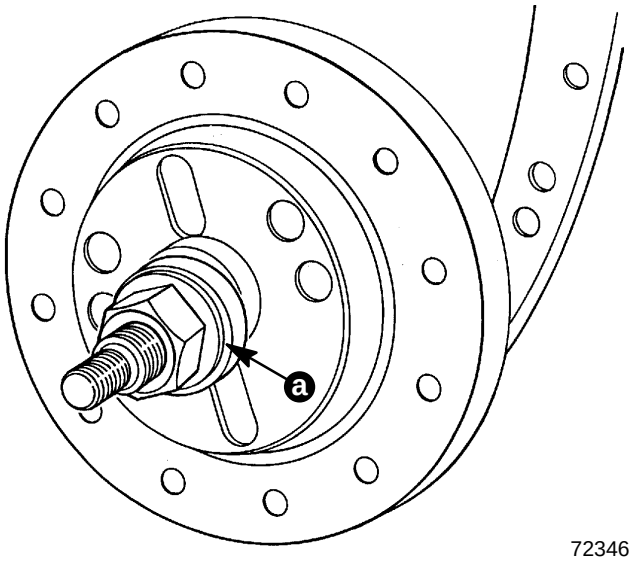
Installation

IMPORTANT: The inertia weight section of torsional damper is assembled to the hub with a rubber type material. The installation procedure (with proper tool) must be followed or movement of the inertia weight on the hub will destroy the tuning of the torsional damper.

1. Replace key in crankshaft if it is damaged.
2. Coat seal surface of torsional damper with engine oil.
3. Install torsional damper on crankshaft, using Torsional Damper Remover and Installer as follows:
   a. Install appropriate end of threaded rod into crankshaft.

IMPORTANT: Be sure to install threaded rod in crankshaft at least 1/2 in. (13 mm) to prevent damage to threads.

   b. Install plate, thrust bearing, washer and nut on rod.
   c. Install torsional damper on crankshaft by turning nut until it bottoms out.



72346

a - Torsional Damper Remover and Installer (J-23523-E)

   d. Remove tool from crankshaft.
   e. To prevent oil leakage, apply Quicksilver RTV sealant to keyway.
   f. Install torsional damper bolt. Torque to 90 lb. ft. (122 N·m).
4. Install drive pulley and water pump pulley. Torque bolts to 35 lb. ft. (48 N·m).
5. Install and adjust drive belts.

Crankcase Front Cover/ Oil Seal

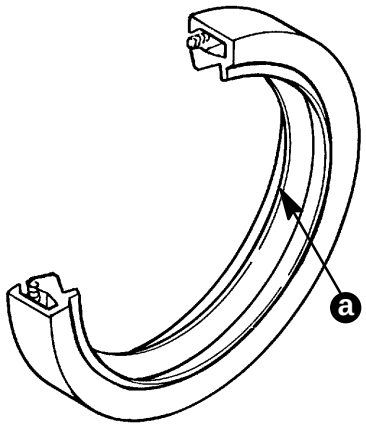
Oil Seal Replacement (Without Removing Front Cover)

REMOVAL

1. Remove torsional damper.
2. Pry seal out of cover from the front with a large screwdriver, being careful not to distort front cover or damage crankshaft.

INSTALLATION

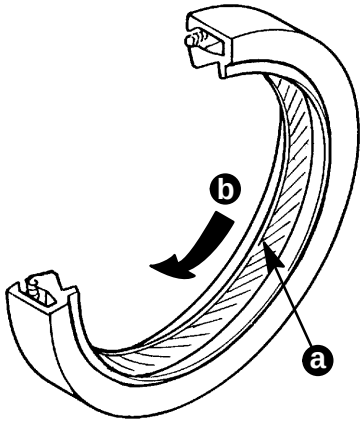
IMPORTANT: Correct rotation oil seal must be used to prevent oil leak.



73123

Front Seal WITHOUT Helical Grooves

a - Seal Lip Toward Inside of Engine

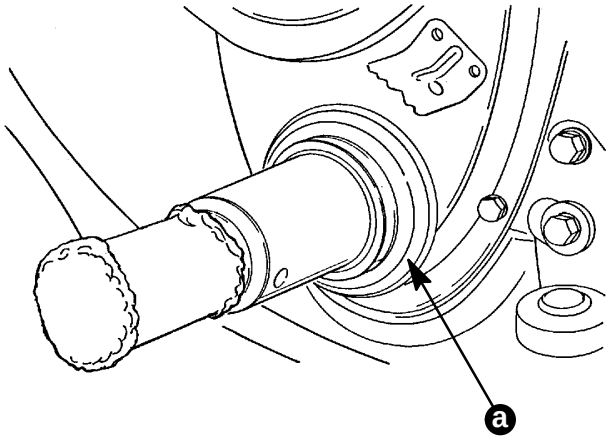


73124

Front Seal WITH Helical Grooves

a - Seal Lip Toward Inside Of Engine
b - Rotation Of Crankcase As Viewed From Front End Looking Toward Flywheel End.

1. Apply Quicksilver Perfect Seal to seal retainer mating surface and apply grease to seal lips.
2. Install new seal with open end of seal inward (lip of seal toward inside of engine), using crankcase front cover seal installer. Drive seal in until it just bottoms out. Do not use excessive force.



72560

a - Crankcase Front Cover Seal Installer (J-22102)

3. Reinstall torsional damper as outlined.

Crankcase Front Cover

Removal

1. Remove engine from boat.
2. Remove torsional damper and oil pan.
3. Remove water circulating pump.
4. Remove crankcase front cover.
5. If damaged, drive oil seal out of front cover (from the rear) using a punch.

Cleaning and Inspection

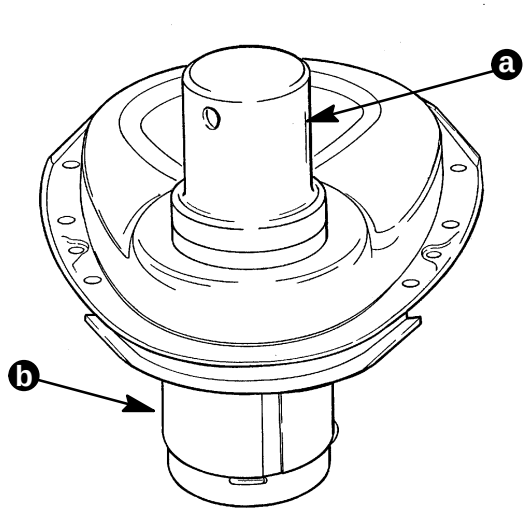
IMPORTANT: The Gen VI front cover is cast aluminum that has a molded o-ring style gasket. This gasket is retained in a cast groove. It must be replaced if damaged.

1. Clean front cover in solvent and dry with compressed air.
2. Clean old gasket material and sealer from mating surfaces on cover and cylinder block.
3. Check gasket surface on front cover for distortion, and true if necessary. Surfaces must be clean and flat or oil leakage may result.

Index

Installation

1. Install oil seal in cover with lip of seal toward inside of engine, using crankcase front cover seal installer. Support cover around seal area with appropriate tool as shown.



72945

a - Crankcase Front Cover Seal Installer (J-22102)
b - Support (To Prevent Distorting Cover)

2. Coat both sides of front cover gasket with Quicksilver Perfect Seal and place in position on engine.
3. Install front cover, making sure holes in cover align with dowel pins in block. Torque front cover attaching bolts to 120 lb. in. (14 N·m).
4. Install oil pan and torsional damper as outlined.
5. Install water circulating pump.
6. Reinstall engine in boat.
7. Fill crankcase with engine oil.
8. Follow procedures in Section 6A or 6B of this manual:

   Seawater Cooled Models: Provide for adequate water supply to seawater pickup (see Section 6A).

   Closed Cooled Models: Refill closed cooling section (see Section 6B), and provide adequate water supply to seawater pickup.

⚠CAUTION

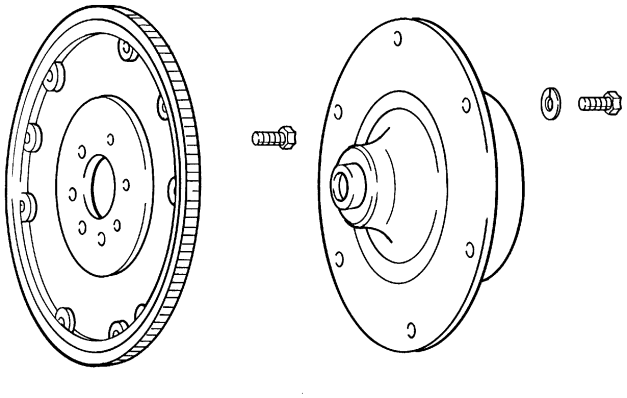
Ensure that cooling water supply is available before starting the engine.

9. Start engine and check for water and oil leaks.

Flywheel

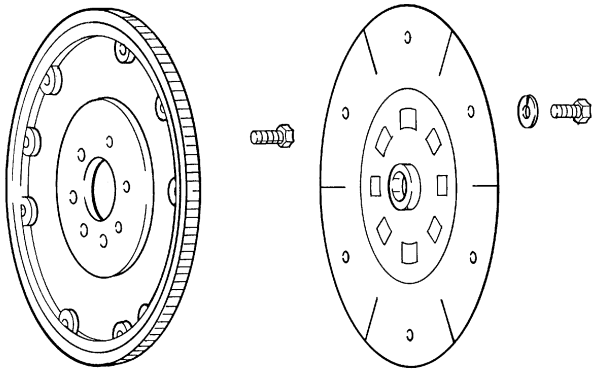
Removal

1. Remove engine from boat.
2. Remove transmission, if so equipped.
3. Refer to “Flywheel Housing” description in this section and remove flywheel housing and related parts.
4. Remove MCM coupler or MIE drive plate.
5. Remove flywheel.



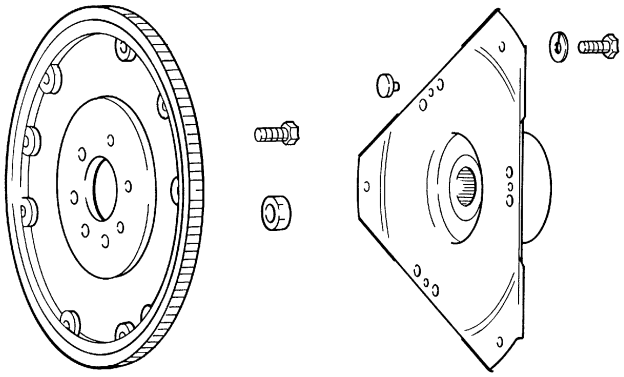
72350

Bravo Coupler



72351

MIE Drive Plate



72352

Drive Shaft Extension Coupler

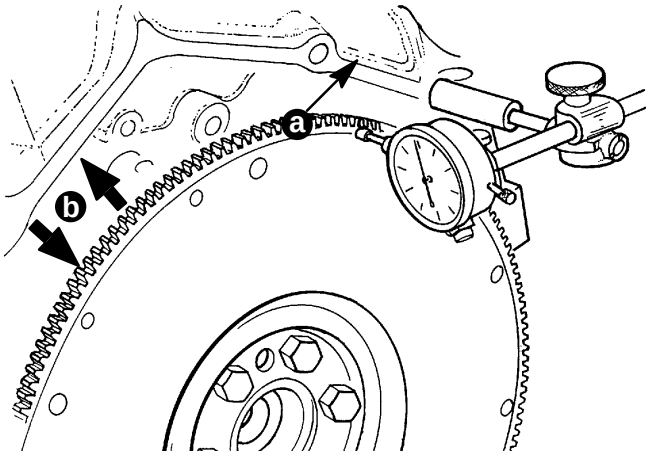
Inspection

1. Inspect splines in drive plate or coupler for wear.
2. Check flywheel ring gear for worn and missing teeth.

Installation

NOTE:*If crankshaft is to be replaced, but old pilot bushing is to be reused, bushing can be removed without damage by filling pilot bushing cavity with grease, then inserting an old transmission input shaft in bore of bushing and hitting it with a hammer. This will create hydraulic pressure in pilot bushing cavity which should force bushing out.*

1. Clean mating surfaces of flywheel and crankshaft. Remove any burrs. Mating surfaces must be clean bare metal.
2. Aligning dowel hole in flywheel with dowel in crankshaft, install flywheel. Torque bolts to 70 lb. ft. (95 N·m).
3. Check flywheel runout as follows:
   a. Attach a dial indicator to engine block.
   b. Take readings around outer edge of flywheel. Push in on flywheel to remove crankshaft end play.
   c. Maximum runout - .008 in. (0.203 mm).



72353

a - .008 in. (0.203 mm) Max. Runout
b - Pus Flywheel And Crankshaft Forward As Far As It Will Go When Taking Reading

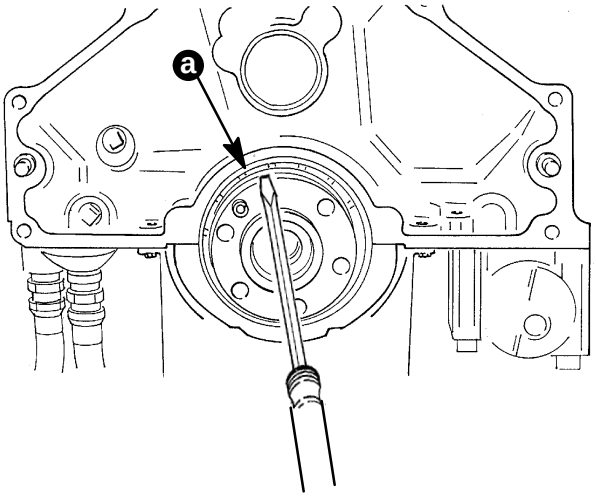
4. Install drive coupler or drive plate. Torque bolts to 35 lb. ft. (48 N·m).
5. Install flywheel housing and related parts. Torque bolts to 30 lb. ft. (41 N·m).
6. Install flywheel housing cover. Torque bolts to 80 lb. in. (9 N·m).
7. Install transmission (MIE). Torque bolts to 50 lb. ft. (68 N·m).
8. Refer to Section 2 “Removal and Installation” and install engine.

Rear Main Oil Seal

The rear crankshaft oil seal can be replaced without removing the oil pan or rear main bearing cap from engine.

Removal

Remove seal by using a screwdriver to pry it out of engine block as shown.



72559

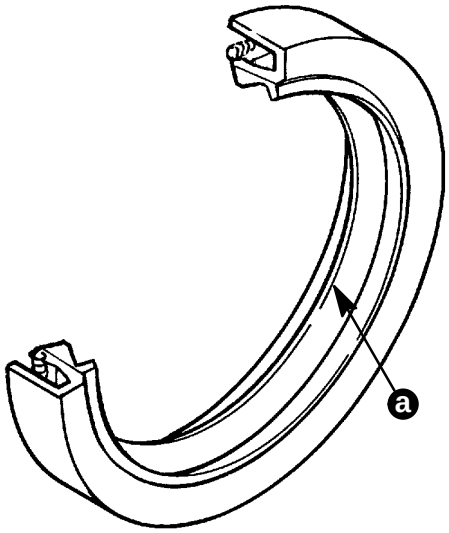
a - Rear Main Seal (Crankshaft Oil Seal)

IMPORTANT: Do not nick or gouge the engine block or rear main bearing cap sealing surface. Protect end of crankshaft and crankshaft/seal running surface from damage, also.

Cleaning and Inspection

Clean crankshaft/seal running surface and seal retainer.

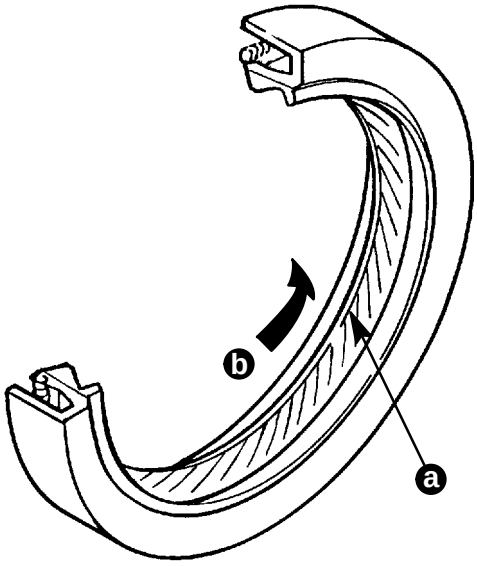
IMPORTANT: Correct rotation oil seal must be used to prevent oil leak.



73126

Rear Seal WITHOUT Helical Grooves

a - Seal Lip Towards Inside Of Engine



72618

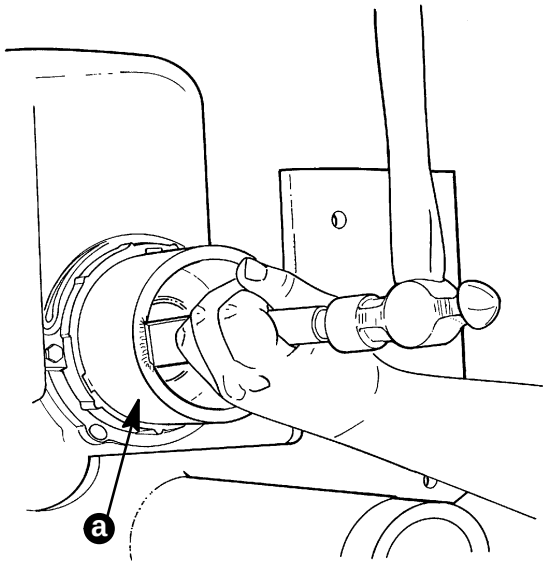
Rear Seal WITH Helical Grooves

a - Seal Lip Toward Inside Of Engine

b - Rotation of Crankshaft As Viewed From Flywheel End Looking Forward

Installation

1. Apply Quicksilver Perfect Seal to engine block/seal mating surface. Apply grease to seal lips.
2. Install seal using rear main seal installer or suitable device.



72356

a - Suitable Device Shown (Rear Main Seal Installer (J-38841) Not Shown

Main Bearings

IMPORTANT: Before removing main bearing caps or connecting rod caps, mark them for reassembly in their original locations.

Main bearings are of the precision insert type and do not use shims for adjustment. If clearances are found to be excessive, a new bearing, both upper and lower halves, will be required. Service bearings are available in standard size and .001 in., .002, .010 in. and .020 in. undersize.

Inspection

In general, the lower half of the bearing (except No. 1 bearing) shows a greater wear and the most distress from fatigue. If, upon inspection, the lower half is suitable for use, it can be assumed that the upper half is also satisfactory. If the lower half shows evidence of wear or damage, both upper and lower halves should be replaced. Never replace one half without replacing the other half.

Checking Clearances

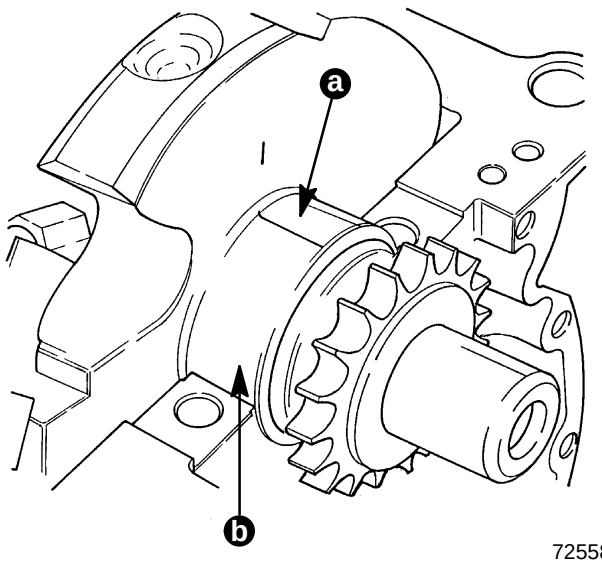
To obtain accurate measurements while using Plastigage, or its equivalent, engine must be out of the boat and upside down so crankshaft will rest on the upper bearings and total clearance can be measured between lower bearing and journal.

To assure the proper seating of the crankshaft, all bearing cap bolts should be at their specified torque. In addition, preparatory to checking fit of bearings, the surface of the crankshaft journal and bearing should be wiped clean of oil.

IMPORTANT: Inspect bearing caps for orientation marks prior to removal. If no markings exist, make suitable marks before disassembly so that they can be reinstalled in their original locations.

1. With the oil pan and oil pump removed, make suitable marks, if required, on bearing cap(s) to be inspected. Remove bearing cap(s) as needed. Wipe oil from journal and bearing cap to be inspected.
2. Place a piece of gauging plastic the full width of the bearing (parallel to the crankshaft) on the journal as shown.

IMPORTANT: Do not rotate the crankshaft while the gauging plastic is between the bearing and journal.

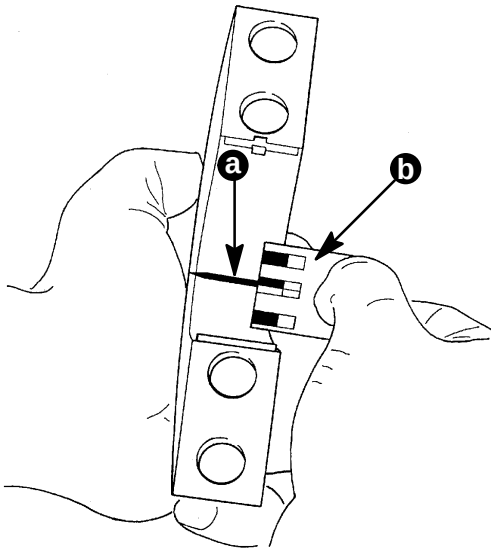


72558

a - Gauging Plastic
b - Journal

3. Install the bearing cap and evenly torque the retaining bolts to specifications. Bearing cap MUST be torqued to specification in order to assure proper reading. Variations in torque affect the compression of the plastic gauge.

4. Remove bearing cap. The flattened gauging plastic will be found adhering to either the bearing cap or journal.
5. On the edge of the gauging plastic envelope there is a graduated scale which is correlated in thousandths of an inch. Without removing the gauging plastic, measure its compressed width (at the widest point) with the graduations on the gauging plastic envelope as shown.



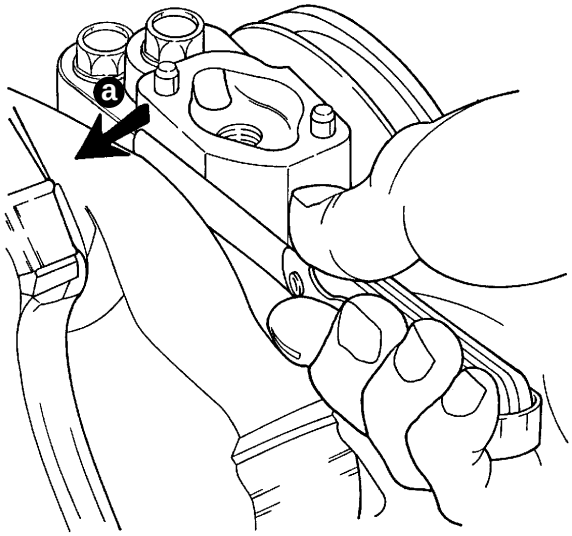
72557

a - Compressed Gauging Plastic
b - Graduated Scale

NOTE:*Normally main bearing journals wear evenly and are not out of round. However, if a bearing is being fitted to an out-of-round journal (.001 in. max.), be sure to fit to the maximum diameter of the journal: If the bearing is fitted to the minimum diameter, and the journal is out of round .001 in., interference between the bearing and journal will result in rapid bearing failure. If the flattened gauging plastic tapers toward the middle or ends, there is a difference in clearance indicating taper, low spot or other irregularity of the bearing or journal. Be sure to measure the journal with a micrometer if the flattened gauging plastic indicates more than .001 in. difference.*

6. If the bearing clearance is within specifications, the bearing insert is satisfactory. If the clearance is not within specifications, replace the insert. Always replace both upper and lower inserts as a unit.
7. A standard, or .001 in., undersize bearing may produce the proper clearance. If not, it will be necessary to regrind the crankshaft journal for use with the next undersize bearing.

   After selecting new bearing, recheck clearance.
8. Proceed to the next bearing. After all bearings have been checked, rotate the crankshaft to see that there is no excessive drag. When checking No. 1 main bearing, loosen accessory drive belts so as to prevent tapered reading with plastic gauge.
9. Measure crankshaft end play (see “Specifications”) by forcing the crankshaft to the extreme front position. Measure at the front end of the rear main bearing with a feeler gauge as shown.

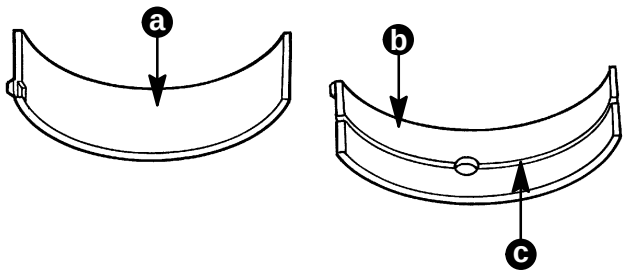


72543

a - Measuring Crankshaft End Play - (Force Crankshaft To Extreme Forward Position)

Replacement

NOTE:*Main bearings may be replaced with or without removing crankshaft.*



72359

Main Bearing Inserts

a - Lower Bearing Insert (Install In Cap)
b - Upper Bearing Insert (Install In Block)
c - Oil Groove

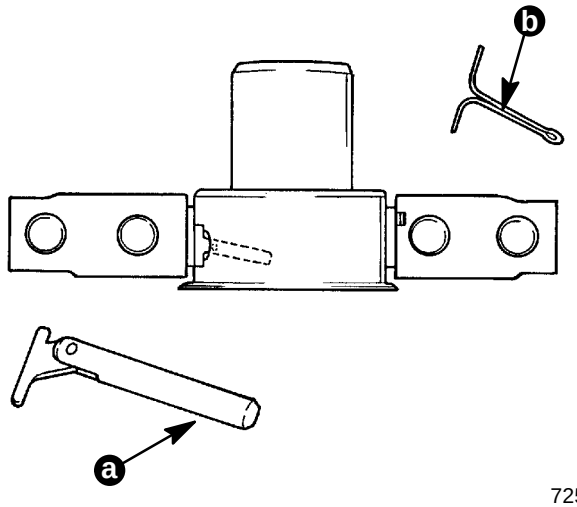
WITH CRANKSHAFT REMOVED

1. Remove and inspect the crankshaft as outlined.
2. Remove the main bearings from the cylinder block and main bearing caps.
3. Coat bearing surfaces of new, correct size, main bearings with oil and install in the cylinder block and main bearing caps.
4. Install the crankshaft.

WITHOUT CRANKSHAFT REMOVED

IMPORTANT: Inspect bearing caps for orientation marks prior to removal. If no markings exist, make suitable marks before disassembly so that they can be reinstalled in their original locations.

1. With oil pan, oil pump and spark plugs removed, make suitable marks on cap and remove cap on main bearing requiring replacement. Remove bearing from cap.
2. Install main bearing remover/installer in oil hole in crankshaft journal. If such a tool is not available, a cotter pin may be bent, as shown, to do the job.



72556

a - Main Bearing Remover / Installer (J-8080)
b - Cotter Pin

3. Rotate the crankshaft clockwise as viewed from the front of engine. This will roll upper bearing out of block.
4. Oil new selected size upper bearing and insert plain (no notched) end between crankshaft and indented or notched side of block. Rotate the bearing into place and remove tool from oil hole in crankshaft journal.
5. Oil new lower bearing and install in bearing cap.
6. Install main bearing cap with marks made on disassembly (or arrows, if present) pointing toward front of engine.
7. Torque all main bearing caps, EXCEPT THE REAR MAIN CAP, to 110 lb. ft. (149 N·m). Torque rear main bearing cap to 10-12 lb. ft. (14-16 N·m); then tap end of crankshaft, first rearward then forward with a lead hammer. This will line up rear main bearing and crankshaft thrust surfaces. Torque rear main bearing cap to 110 lb. ft. (149 N·m).

Connecting Rod Bearings

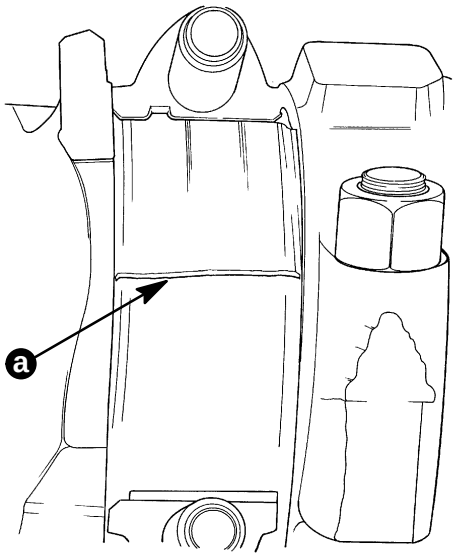
Connecting rod bearings are of the precision insert type and do not use shims for adjustment. DO NOT FILE RODS OR ROD CAPS. If clearances are found to be excessive, a new bearing will be required. Service bearings are available in standard size and .001 in. and .002 in. undersize for use with new and used standard size crankshafts, and in .010 in. and .020 in. undersize for use with reconditioned crankshafts.

Inspection and Replacement

IMPORTANT: Before you remove the connecting rod cap, mark the side of the rod and cap with the cylinder number to assure matched reassembly of rod and cap.

1. With oil pan and oil pump removed, mark the side of the rod and cap with the cylinder number and remove the connecting rod cap and bearing.
2. Inspect the bearing for evidence of wear and damage. Do not reinstall a worn or damaged bearing.
3. Wipe both upper and lower bearing shells and crank pin clean of oil.

4. Measure the crankpin for out-of-round or taper with a micrometer. If not within specifications, replace or recondition the crankshaft. If within specifications and a new bearing is to be installed, measure the maximum diameter of the crankpin to determine new bearing size required.
5. If within specifications, measure new or used bearing clearances with gauging plastic or its equivalent. If a bearing is being fitted to an out-of-round crankpin, be sure to fit to the maximum diameter of the crankpin. If the bearing is fitted to the minimum diameter, and the crankpin is out of round .001 in., interference between the bearing and crankpin will result in rapid bearing failure.
   a. Place a piece of gauging plastic, the length of the bearing (parallel to the crankshaft), on the crankpin or bearing surface as shown. Position the gauging plastic in the middle of the bearing shell. (Bearings are eccentric and false readings could occur if placed elsewhere.)

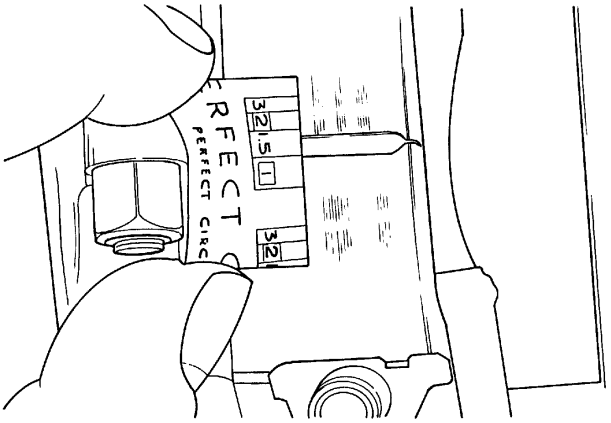


72361

a - Gauging Plastic

   b. Install the bearing in the connecting rod and cap.
   c. Install the bearing cap and evenly torque nuts. Refer to “Specifications”.
   d. Remove the bearing cap and using the scale on the gauging plastic envelope, measure the gauging plastic width at the widest point as shown.

IMPORTANT: Do not turn the crankshaft with the gauging plastic installed.

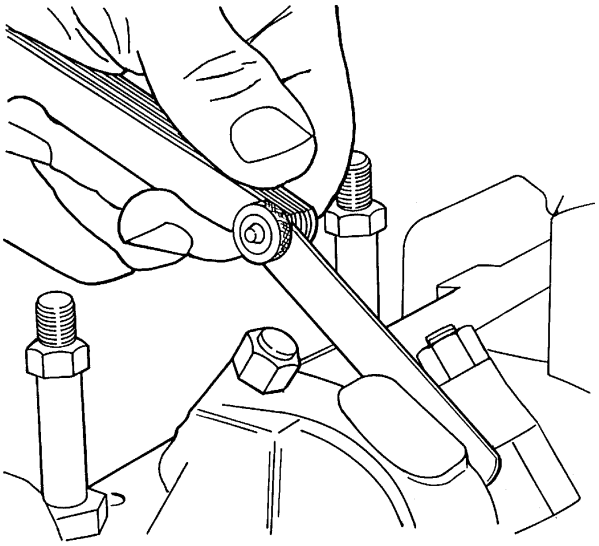


72362

6. If the clearance exceeds specifications, select a new, correct size bearing and measure the clearance.

   Be sure to check what size bearing is being removed in order to determine proper replacement size bearing. If clearance cannot be brought to within specifications, the crankpin will have to be ground undersize. If the crankpin is already at maximum undersize, replace crankshaft.
7. Coat the bearing surface with oil, install the rod cap and torque nuts
   3/8 in. nuts 50 lb. ft. (68 N·m)
   7/16 in. nuts 73 lb. ft. (99 N·m).

8. When all connecting rod bearings have been installed, tap each rod lightly (parallel to the crankpin) to make sure they have clearance.
9. Measure all connecting rod side clearances (see “Specifications”) between connecting rod caps as shown.



72555

Connecting Rod/Piston Assembly

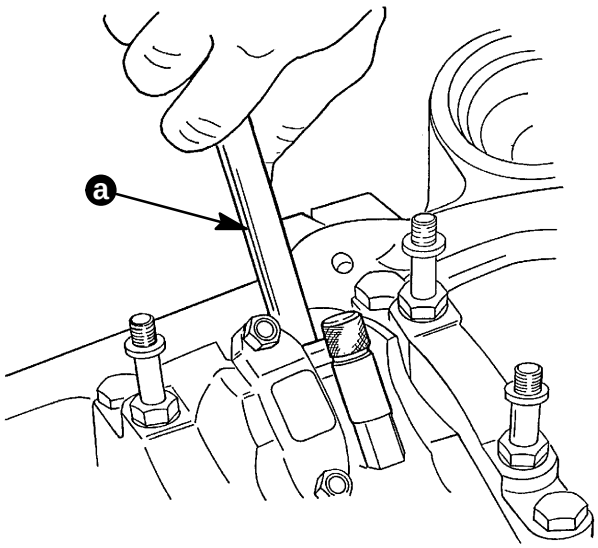
Removal

1. Remove as outlined:
   a. Oil pan and dipstick tube.
   b. Baffle and oil pump.
   c. Distributor and intake manifold.
   d. Cylinder heads.
2. Use a ridge reamer to remove any ridge and/or deposits from upper end of cylinder bore.

IMPORTANT: Before ridge and/or deposits are removed, turn crankshaft until piston is at bottom of stroke and place a cloth on top of piston to collect cuttings. After ridge and/or deposits are removed, turn crankshaft until piston is at top of stroke, then remove cloth and cuttings.

3. Mark connecting rods and bearing caps (left bank 1, 3, 5 and 7; right bank 2, 4, 6 and 8 from front to rear on same side as piston thrust).
4. Remove connecting rod cap and install connecting rod bolt guide (3/8-24 or 7/16-20) on bolts. Push connecting rod and piston assembly out of top of cylinder block.

NOTE:*It will be necessary to turn crankshaft slightly to disconnect and remove some connecting rod and piston assemblies.*

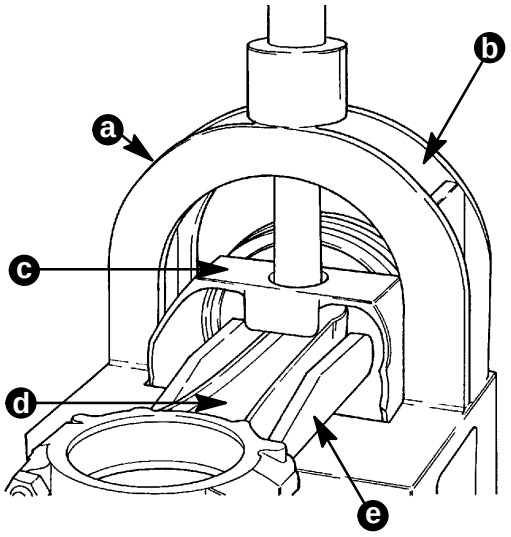


72572

a - Connecting Rod Bolt Guide 3/8-24 (J-5239) or 7/16-20 (J-35228)

Disassembly

Disassemble piston from connecting rod using piston pin remover as shown. Follow instructions supplied with kit.



72365

a - Piston Pin Remover and Installer Kit (J-24086-C)
b - Arched Base
c - Piston
d - Connecting Rod
e - Rod Support

Cleaning and Inspection

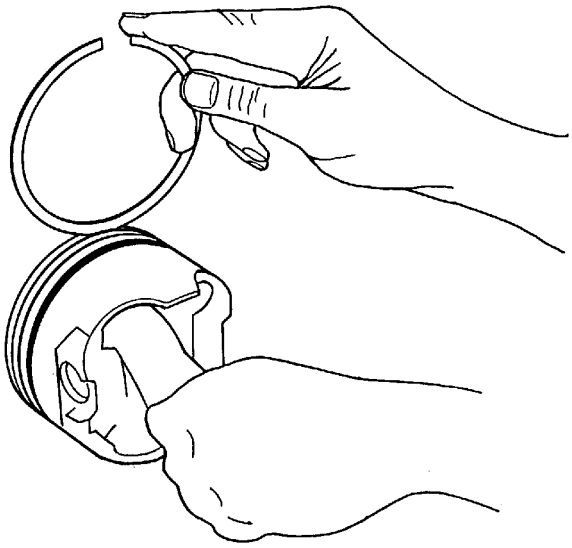
CONNECTING RODS

1. Wash connecting rods in cleaning solvent and dry with compressed air.
2. Check for twisted and bent rods and inspect for nicks and cracks. Replace damaged connecting rods.

PISTONS

NOTE:*Cylinder bore and taper must be within specifications before pistons can be considered for re-use.*

1. Clean varnish from piston skirts with a cleaning solvent. DO NOT WIRE BRUSH ANY PART OF PISTON. Clean ring grooves with a groove cleaner and make sure oil ring holes are clean.
2. Inspect piston for cracked ring lands, skirts and pin bosses, wavy worn ring lands, scuffed or damaged skirts, and eroded areas at top of piston. Replace pistons which are damaged or show signs of excessive wear.
3. Inspect grooves for nicks and burrs that might cause rings to hang up.
4. Measure piston skirt and check clearance as outlined under “Piston Selection.”
5. Slip outer surface of a new top and second compression ring into respective piston ring groove and roll ring entirely around the groove to make sure that ring is free as shown. If binding occurs at any point, determine cause. If caused by ring groove, remove by dressing with a fine cut file. If binding is caused by a distorted ring, recheck with another ring.



72366

6. Proper clearance of piston ring in its piston ring groove is very important to provide proper ring action and reduce wear. Therefore, when fitting new rings, clearances between ring and groove surfaces should be measured. See “Specifications.”

72367

Index

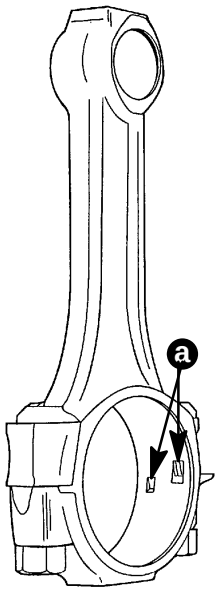
PISTON PINS

1. Piston pin clearance is designed to maintain adequate clearance under all engine operating conditions. Because of this, piston and piston pin are a matched set and not serviced separately.
2. Inspect piston pin bores and piston pins for wear. Piston pin bores and piston pins must be free of varnish and scuffing when measured. Measure piston pin with a micrometer and piston pin bore with a dial bore gauge or inside micrometer. If clearance is in excess of the .001 in. (0.025 mm) wear limit, replace piston and piston pin assembly.

Reassembly

IMPORTANT: When reassembling pistons and connecting rods, the following must be kept in mind.

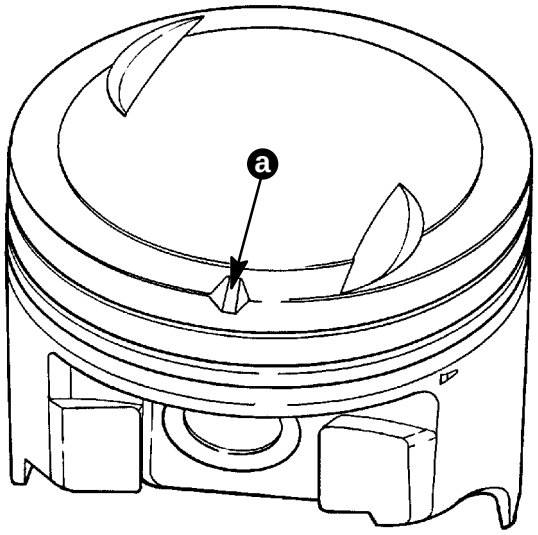
- **Piston and pin are machine fitted to each other and must remain together as a matched set. Do not intermix pistons and pins.**
- **If original pistons and/or connecting rods are being used, be sure to assemble pistons and connecting rods so they can be reinstalled in same cylinder from which they were removed.**
- **Connecting rod bearing tangs are always toward outside of cylinder block.**



72368

a - Rod Bearing Tangs

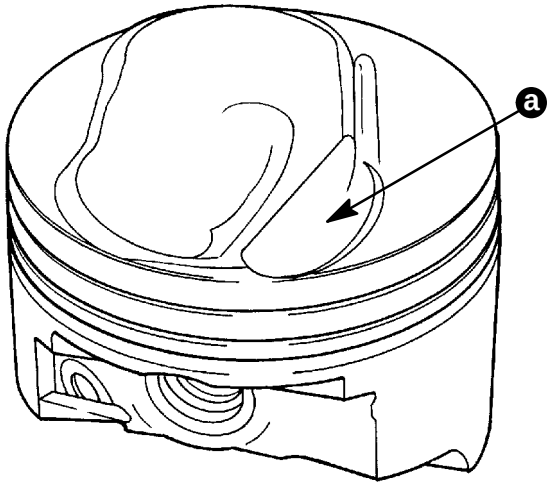
- **Notch or valve relief in piston must be positioned correctly for engine that is being repaired.**



72554

7.4L Engine

a - Notch - Toward Front Of Engine

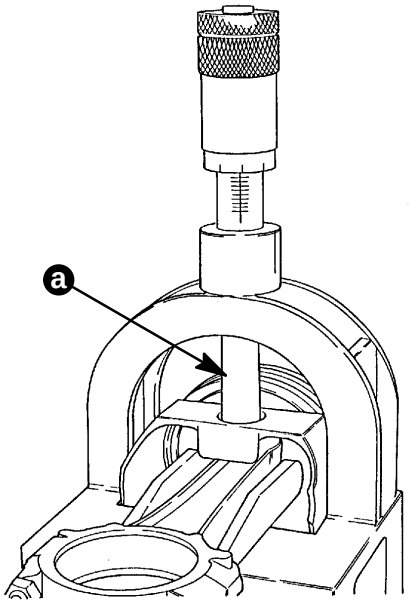


72553

454 Magnum / 502 Magnum / 8.2L

a - Valve Relief - Toward Center Of Engine

1. Assemble piston to connecting rod using piston pin remover as shown. Follow instructions supplied with kit.



72371

a - Piston Pin Remover (J-24086-C)

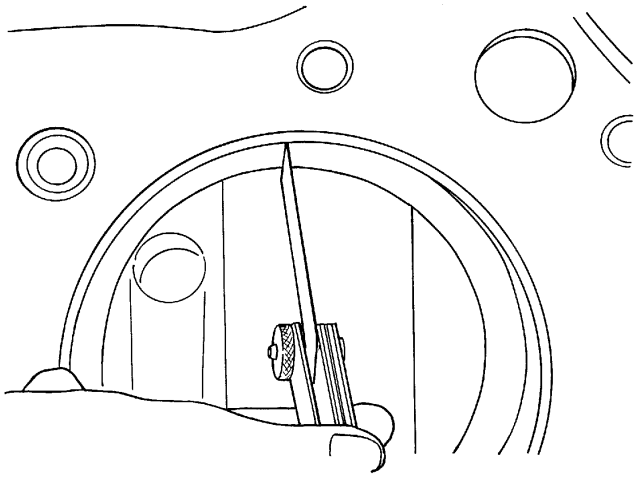
2. Once assembled, check piston for freedom of movement (back-and-forth and up-and-down) on connecting rod. Piston should move freely in all directions. If it does not, piston pin bore is tight and piston/pin assembly must be replaced.
3. If a new connecting rod has been installed, mark connecting rod and cap (on side of rod and cap with slots for connecting rod bearing tangs) with cylinder number in which it will be installed.

PISTON RINGS

All compression rings are marked on upper side of ring. When installing compression rings, make sure that marked side is toward top of piston.

Oil control rings are a three-piece type, consisting of two rings and a spacer.

1. Select rings comparable in size to cylinder bore and piston size.
2. Slip compression ring in cylinder bore, then press ring down into cylinder bore about 1/4 in. (6 mm) (below ring travel). Be sure that ring is square with cylinder wall.
3. Measure gap between ends of ring with a feeler gauge as shown.



72372

4. If gap between ends of ring is below specifications, remove ring and try another for fit.
5. Fit each compression ring to cylinder in which it is going to be used.
6. Clean and inspect pistons, if not previously done.
7. Install piston rings as follows:
   a. Install oil ring spacer in groove and insert anti-rotation tang in oil hole.
   b. Hold spacer ends butted and install lower steel oil ring rail with gap properly located.
   c. Install upper steel oil ring rail with gap properly located.
   d. Flex the oil ring assembly to make sure ring is free. If binding occurs at any point, the cause should be determined and, if caused by ring groove, removed by dressing groove with a fine cut file. If binding is caused by a distorted ring, use a new ring.

IMPORTANT: Use piston ring expander (91-24697) for compression ring installation.

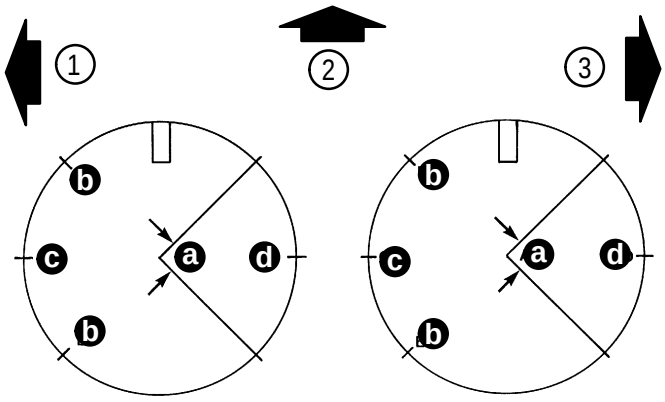
   e. Install lower compression ring with marked side up, using ring expander.
   f. Install top compression ring with marked side up, using ring expander.

Installation

IMPORTANT: Cylinder bores must be clean before piston installation. Clean with a light honing, as necessary. Then clean with hot water and detergent wash. After cleaning, swab bores several times with light engine oil and clean cloth, then wipe with a clean dry cloth.

1. Lubricate connecting rod bearings and install in rods and rod caps.
2. Lightly coat pistons, rings and cylinder walls with light engine oil.
3. With bearing caps removed, install connecting rod bolt guide (3/8-24, use tool J-5239 or 7/16-20, use tool J-35228) on connecting rod bolts.

IMPORTANT: Be sure ring gaps are properly positioned as shown.



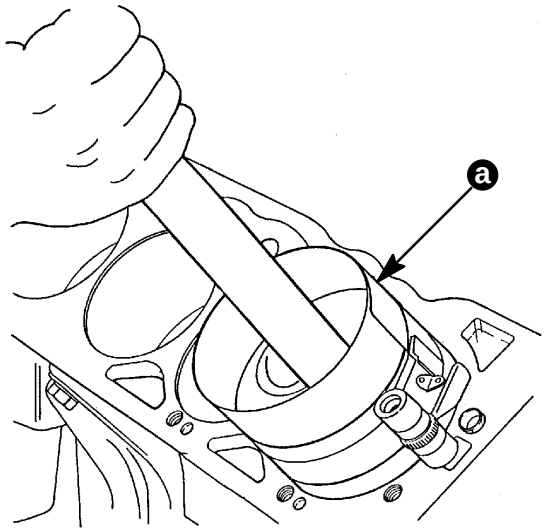
72373

Ring Gap Location

1 - Port Side
2 - Engine Front
3 - Starboard Side
a - Oil Ring Spacer Gap (Tang In Hole Or Slot Within Arc)
b - Oil Ring Gaps
c - 2nd Compression Ring Gap
d - Top Compression Ring Gap

4. Install each connecting rod and piston assembly in its respective bore. Install with connecting rod bearing tangs toward outside of cylinder block. Use piston ring compressor to compress rings. Guide connecting rod into place on crankshaft journal with connecting rod bolt guide. Use a hammer handle with light blows to install piston into bore. Hold ring compressor firmly against cylinder block until all piston rings have entered cylinder bore.

IMPORTANT: Be sure to install new pistons in same cylinders for which they were fitted, and used pistons in same cylinder from which they were removed. Each connecting rod and bearing cap should be marked, beginning at front of engine (1, 3, 5 and 7 in left bank and 2, 4, 6 and 8 in right bank). Numbers on connecting rod and bearing cap must be on same side when installed in cylinder bore. If a connecting rod is ever transposed from one block or cylinder to another, new bearings should be fitted and connecting rod should be numbered to correspond with new cylinder number.



72552

a - Piston Ring Compressor (J-8037)

5. Remove connecting rod bolt guide.
6. Install bearing caps and evenly torque nuts. Refer to “Specifications”.
7. Check connecting rod side clearance as previously described.

NOTE:*If bearing replacement is required, refer to “Connecting Rod Bearings.”*

8. Install as previously outlined:
   a. Oil pump and baffle.
   b. Dipstick and oil pan.
   c. Cylinder heads.
   d. Intake manifold.
   e. Distributor.
9. Fill crankcase with oil. Refer to Section 1 - “Maintenance.”

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Crankshaft

Removal

1. Remove engine from boat.
2. Drain crankcase oil.
3. Remove as outlined:
   a. Starter.
   b. Flywheel housing.
   c. Drive coupler/plate and flywheel.
   d. Belts.
   e. Water pump.
   f. Crankshaft pulley and torsional damper.
   g. Spark plugs.
   h. Oil pan and dipstick tube.
   i. Baffle and oil pump.
   j. Timing chain/gear cover.
4. Turn crankshaft to align timing mark with camshaft mark.
5. Remove camshaft sprocket or gear.
6. Remove rear main seal.

IMPORTANT: Inspect bearing caps for orientation marks prior to removal. If no markings exist, make suitable marks before disassembly so that they can be reinstalled in their original locations.

7. Make sure all bearing caps (main and connecting rods) are marked so they can be reinstalled in their original locations.
8. Remove connecting rod bearing caps, then push piston and rod assemblies toward heads.
9. Remove main bearing caps and carefully lift crankshaft out of cylinder block.
10. If new main and/or connecting rod bearings are to be installed, remove main bearing inserts from cylinder block and bearing caps, and/or connecting rod bearing inserts from connecting rod and caps. Install new bearings following procedures outlined.

Cleaning and Inspection

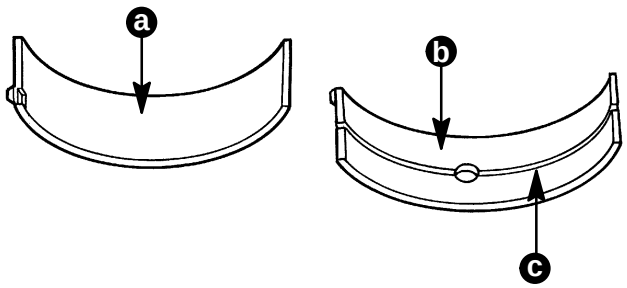
1. Wash crankshaft in solvent and dry with compressed air.
2. Measure main bearing journals and crankpin dimensions with a micrometer for out-of-round, taper or undersize (see “Specifications”).
3. Check crankshaft for runout (by supporting at front and rear main bearings journals in V-blocks) and check at front and rear intermediate journals with a dial indicator (see “Specifications”).
4. Replace or recondition crankshaft if not within specifications.

Installation

1. If a new crankshaft is being installed, proceed as follows:
   a. Remove timing sprocket or gear from old crankshaft and reinstall on new crankshaft as outlined.
   b. On models with drive shaft extension, if old pilot bushing is to be reused, bushing can be removed without damage by filling pilot bushing cavity with grease, then inserting an old transmission input shaft in bore of bushing and hitting it with a hammer. This will create hydraulic pressure in pilot bushing cavity which should force bushing out.

IMPORTANT: Be sure that all bearings and crankshaft journals are clean.

2. Install main bearings in engine block as follows.



72359

Main Bearing Inserts

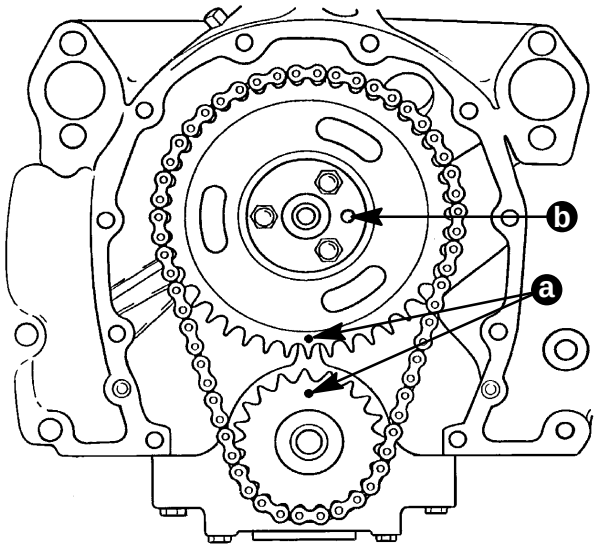
a - Lower Bearing Insert (Install In Cap)
b - Upper Bearing Insert (Install In Block)
c - Oil Groove

3. Carefully lower crankshaft into place. Be careful not to damage bearing surface.
4. Check clearance of each main bearing, following procedure outlined under “Main Bearings.” If bearing clearances are satisfactory, apply engine oil to journals and bearings.
5. Install main bearing caps. Torque bolts to 110 lb. ft. (149 N·m). When tightening rear main bearing cap, follow procedure outlined under “Main Bearings.”
6. Check crankshaft end play as outlined.
7. Check clearance for each connecting rod bearing, following procedure under “Connecting Rod Bearings.” If bearing clearances are satisfactory, apply engine oil to journals and bearings.
8. Install rod caps and evenly torque nuts. Refer to “Specifications”.
9. Turn crankshaft so mark on timing sprocket or gear is facing camshaft.
10. Install as outlined:
    a. Timing chain and sprocket or gear on camshaft -align marks with crankshaft.
    b. Timing chain/gear cover.
    c. Oil pump and baffle.
    d. Dipstick tube and oil pan.
    e. Spark plugs.
    f. Torsional damper and crankshaft pulley.
    g. Water pump.
    h. Belts.
    i. Flywheel and drive coupler/plate.
    j. Flywheel housing.
    k. Starter.
11. Install new oil filter. Fill crankcase with oil.

Timing Chain and Sprocket

Removal

1. Remove torsional damper, oil pan and crankcase front cover as outlined.
2. Turn crankshaft until timing marks on crankshaft and camshaft sprockets are in alignment as shown.



72946

a - Timing Marks Aligned
b - Locating Pin

3. Remove camshaft sprocket and timing chain. (If sprocket does not come off easily, a light tap on the lower edge of the sprocket, using a plastic mallet, should dislodge it.)
4. If crankshaft sprocket requires replacement, remove as outlined.

Cleaning and Inspection

1. Clean all parts in solvent and dry with compressed air.
2. Inspect timing chain for wear and damage.
3. Inspect sprockets for wear and damage.

Installation

1. If crankshaft sprocket was removed, install as outlined in “Crankshaft Sprocket.”
2. Install timing chain on camshaft sprocket. Hold sprocket vertical with chain hanging down. Align marks on camshaft and crankshaft sprockets.

IMPORTANT: Do not attempt to drive sprocket on camshaft, as welsh plug at rear of engine can be dislodged.

3. Install sprocket on camshaft. Torque bolts to 25 lb. ft. (34 N·m).
4. Lubricate timing chain with engine oil. Install crankcase front cover and torsional damper as outlined.

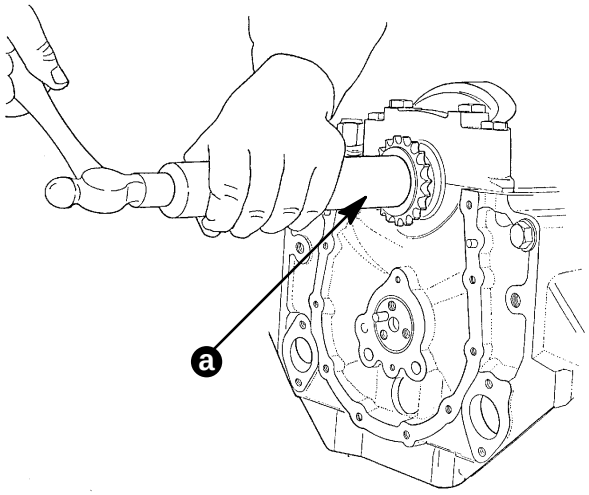
Crankshaft Sprocket

Removal

1. Remove torsional damper and crankcase front cover as outlined.
2. Remove camshaft timing chain as outlined.
3. Remove crankshaft sprocket using crankshaft gear and sprocket puller (J-24420-B).

Installation

1. Using crankshaft gear and sprocket installer, as shown, install sprocket on crankshaft.



72550

a - Crankshaft Gear And Sprocket Installer (J-1058-20)

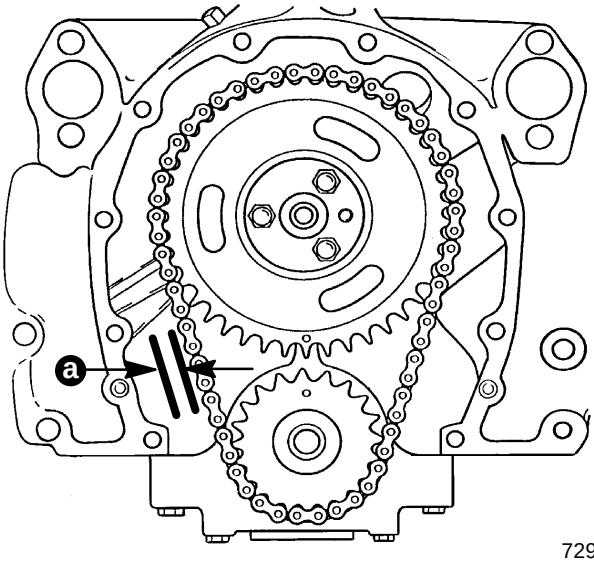
2. Install timing chain as outlined.
3. Install crankcase cover and torsional damper as outlined.

Checking Timing Chain Deflection

With timing chain and sprockets installed, check timing chain deflection, as follows:

1. Rotate camshaft (in either direction) to place tension on one side of the chain.
2. Establish a reference point on the block (on taut side of chain) and measure from this point to the chain.
3. Rotate camshaft in the opposite direction to slacken the chain, then force chain out with fingers and again measure the distance between reference point and timing chain.

4. The deflection is the difference between these two measurements. If the deflection exceeds 3/4 in. (19 mm), timing chain should be replaced.



72946

a - Reference Point

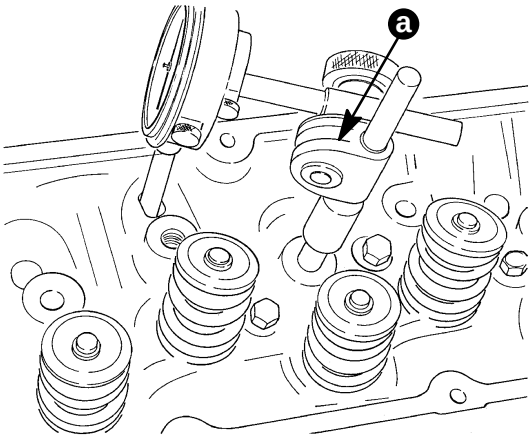
5. Install torsional damper and crankcase front cover.

Camshaft

Measuring Lobe Lift

NOTE:*Procedure is similar to checking valve timing. If improper valve operation is indicated, measure lift of each push rod in consecutive order and record readings.*

1. Remove valve mechanism as outlined.
2. Adapt dial indicator to cylinder head by temporarily installing suitable stud in bolt hole. Position indicator with ball socket adaptor tool, from Lift Indicator Tool Kit, on push rod. Be sure that push rod is in lifter socket.



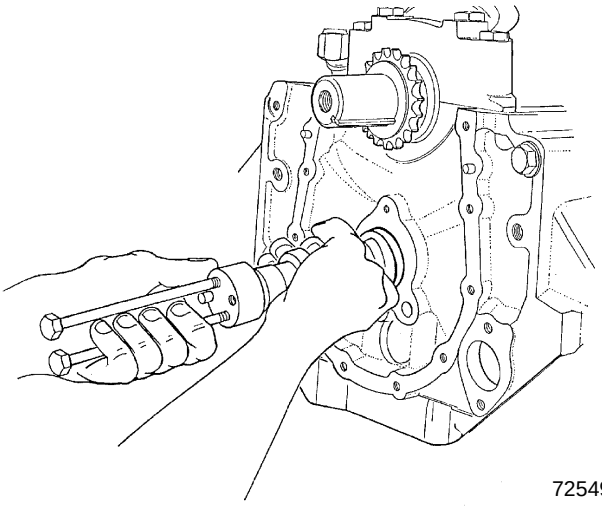
72551

a - Lift Indicator Tool Kit (J-8520)

3. Rotate torsional damper slowly in direction of rotation until lifter is on heel of cam lobe. At this point, push rod will be in its lowest position.
4. Set dial indicator on zero, then rotate damper slowly (or attach an auxiliary starter switch and “bump” engine over) until push rod is in fully raised position.
5. Compare total lift, recorded from dial indicator, with “Specifications.”
6. Continue to rotate engine until indicator reads zero. This will be a check on accuracy of original indicator reading.
7. If camshaft readings for all lobes are within specifications, remove dial indicator assembly and hardware.
8. Install and torque valve mechanism to specifications.

Removal

1. Remove valve lifters as outlined.
2. Remove crankcase front cover as outlined.
3. Remove camshaft as follows:
   a. Remove timing chain and sprocket or timing gears as outlined.
   b. Install two 5/16-18 x 5 in. bolts in camshaft bolt holes and carefully remove camshaft as shown.



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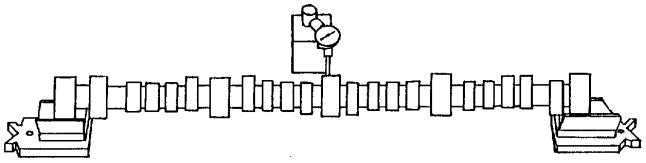
Inspection

Measure camshaft bearing journals with a micrometer for out-of-round condition. If journals exceed .001 in. (0.025 mm) out-of-round, camshaft should be replaced.

Also check camshaft for alignment with V-blocks and dial indicator which indicates exact amount camshaft is out of true. If out more than .002 in. (0.051 mm) (dial indicator reading) camshaft should be replaced.



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Checking Camshaft Alignment

Installation

1. Install camshaft as follows:
   a. Install two 5/16-18 x 5 in. bolts in camshaft bolt holes, then lubricate camshaft journals with engine oil and install camshaft, being careful not to damage bearings.
   b. Lubricate camshaft lobes with General Motors Cam and Lifter Prelube or equivalent.
   c. Install timing chain or gears as outlined.
2. Install crankcase front cover and valve lifters as outlined.

Camshaft Bearings

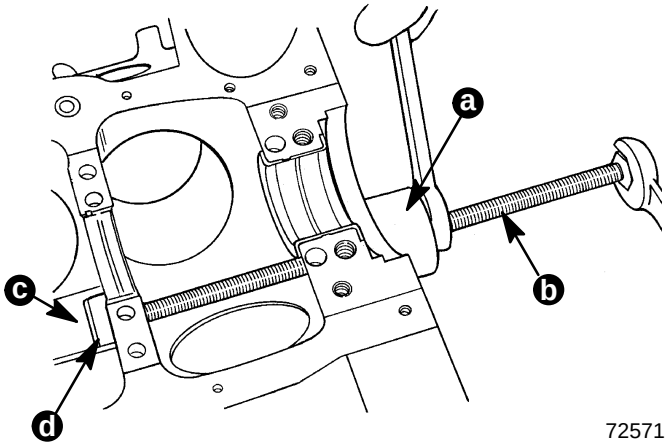
Removal

Camshaft bearings can be replaced while engine is disassembled for overhaul or without complete disassembly. To replace bearings without complete disassembly, remove camshaft and crankshaft, leaving cylinder heads attached and pistons in place. Before removing crankshaft, fasten connecting rods against sides of engine so that they will not interfere while replacing camshaft bearings.

1. With camshaft and crankshaft removed, drive camshaft rear plug from cylinder block.

NOTE:*This procedure is based on removal of bearings from center of engine first, thus requiring a minimum amount of turns to remove all bearings.*

2. Using camshaft bearing remover and installer set (J-6098-01) (with nut and thrust washer installed to end of threads), position pilot in front camshaft bearing and install puller screw through pilot.
3. Install tool with shoulder toward bearing. Be sure a sufficient amount of threads are engaged.
4. Using two wrenches, hold puller screw while turning nut. When bearing has been pulled from bore, remove tool and bearing from puller screw.
5. Remove remaining bearings (except front and rear) in same manner. It will be necessary to position pilot in rear camshaft bearing to remove rear intermediate bearing.



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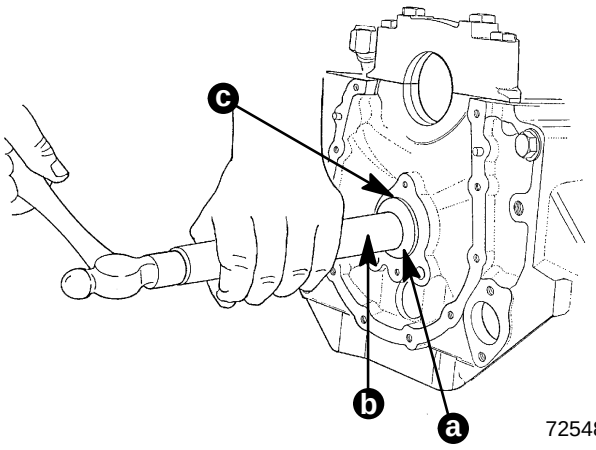
a - Index Point
b - Puller Screw
c - Driver
d - Bearing

6. Assemble driver on driver handle and remove front and rear camshaft bearings by driving toward center of cylinder block.



72548

a - Driver
b - Driver Handle
c - Bearing

Inspection

Clean camshaft bearing bores in cylinder block with solvent and blow out with compressed air. Be sure grooves and drilled oil passages are clean.

Installation

Front and rear bearings must be installed last as pilot will not fit into bearing bores if bearings are installed.

Lubricate outer surface of new camshaft bearings with engine oil to ease installation.

IMPORTANT: All camshaft bearings are not the same. Be sure to install bearings in proper locations (Indicated by bearing manufacturer) and to position bearings as follows (directional references are in reference to engine in its normal operating position):

- **Front bearing must be positioned so that oil holes are equal distance from 6 o'clock position in the block. Intermediate and center bearings must be positioned so that oil holes are at the 5 o'clock position (toward left side of block and at a position even with bottom of cylinder bore). Rear bearing must be positioned so that oil hole is at the 12 o'clock position.**

1. Installing intermediate and center bearings:
   a. Install nut and thrust washer all the way onto puller screw, then position pilot in front camshaft bearing bore and insert screw through pilot.
   b. Index center camshaft bearing, then position appropriate size remover and installer tool in bearing and thread puller screw into tool. Be sure at least 1/2 in. (13 mm) of threads are engaged.
   c. Using two wrenches, hold puller screw and turn nut until bearing has been pulled into position. Remove the remover and installer tool and check to ensure that oil hole(s) in bearing are positioned correctly.
   d. Install intermediate bearings in same manner being sure to index bearings correctly. It will be necessary to position pilot in rear camshaft bearing bore to install rear intermediate bearing.
2. Installing front and rear bearings:
   a. Install appropriate size remover and installer tool on drive handle.

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b. Index front bearing (as explained in “Important” above), and drive it into position with tool. Check position of oil hole(s) in bearing to ensure bearing is positioned correctly.

c. Install rear bearing in same manner, being sure to index bearing correctly.

3. Install a new camshaft rear plug.

IMPORTANT: Plug must be installed flush to 1/32 in. (0.8 mm) deep and must be parallel with rear surface of cylinder block.

4. Install crankshaft and camshaft as outlined.

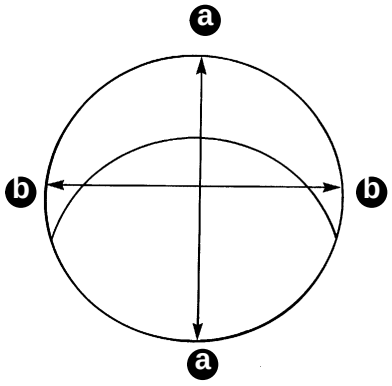
Cylinder Block

Cleaning and Inspection

1. Remove all engine components as previously outlined.
2. Wash cylinder block thoroughly in cleaning solvent and clean all gasket surfaces.
3. Remove oil gallery plugs and clean all oil passages.
4. Remove expansion plugs.

NOTE:*These plugs may be removed with a sharp punch, or they may be drilled and pried out.*

5. Clean and inspect water passages in cylinder block.
6. Inspect cylinder block for cracks in cylinder walls, water jacket valve lifter bores and main bearing webs.
7. Measure cylinder walls for taper, out-of-round or excessive ridge at top of ring travel. This should be done with a dial indicator or inside micrometer. Carefully work gauge up and down cylinder to determine taper and turn it to different points around cylinder wall to determine out-of-round condition. If cylinders exceed specifications, boring and/or honing will be necessary.



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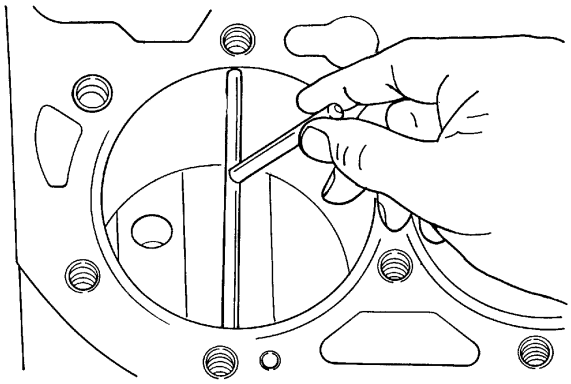
Cylinder Measurement

a - Equal To Right Angle To Centerline Of Engine
b - Parallel to Centerline Of Engine ”Out Of Round” Equals The Difference Between A and B At Top Of Cylinder Bore and A Measurement At Bottom Of Cylinder Bore



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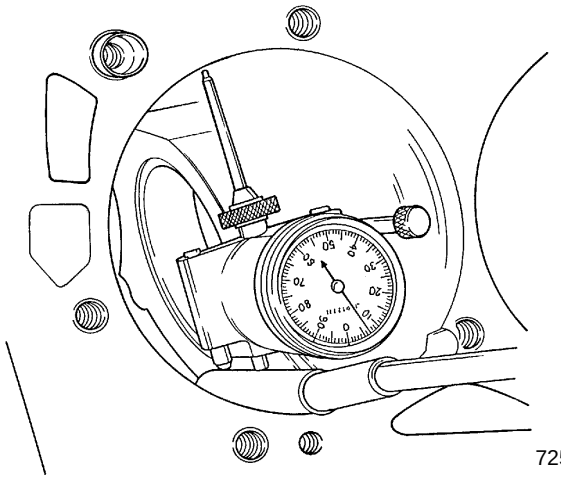
Measuring Cylinder Bore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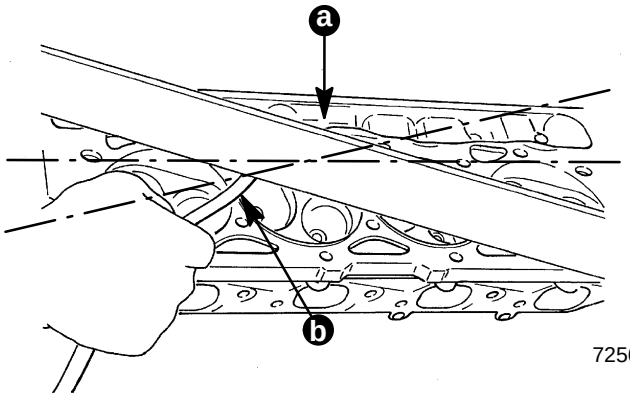
Measuring Cylinder Bore

8. Check cylinder head gasket surfaces for warpage with a machinist's straight-edge and a feeler gauge, as shown. Take measurements diagonally across surfaces (both ways) and straight down center. If surfaces are warped more than .003 in. (0.07 mm) in a 6 in. area or .007 in. (0.2 mm) overall, block must be resurfaced by an automotive machine shop.



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a - Machinist's Straight Edge
b - Feeler Gauge

CYLINDER CONDITIONING

1. Performance of the following operation depends upon engine condition at time of repair.
2. If cylinder block inspection indicates that block is suitable for continued use (except for out-of-round or tapered cylinders), they can be conditioned by honing or boring.
3. If cylinders have less than .005 in. (0.127 mm) taper or wear, they can be conditioned with a hone and fitted with high limit standard size piston. A cylinder bore of more than .005 in. wear or taper may not clean up entirely when fitted to a high limit piston. To entirely clean up the bore, it will be necessary to bore for an oversize piston. If more than .005 in. taper or wear, bore and hone to smallest oversize that will permit complete resurfacing of all cylinders.
4. When pistons are being fitted and honing is not necessary, cylinder bores may be cleaned with a hot water and detergent wash. After cleaning, swab cylinder bores several times with light engine oil and a clean cloth, then wipe with a clean dry cloth.

CYLINDER BORING

1. Before using any type boring bar, file off top of cylinder block to remove dirt or burrs. This is very important to prevent boring bar tilt, with result that bored cylinder wall is not at right angles to crankshaft.
2. Measure piston to be fitted with a micrometer, measuring at center of piston skirt and at right angles to piston pin. Bore cylinder to same diameter as piston and hone to give specified clearance.

NOTE:*Hone cylinders as outlined under "Cylinder Honing" and "Piston Selection," following.*

3. Carefully observe instructions furnished by manufacturer of equipment being used.

CYLINDER HONING

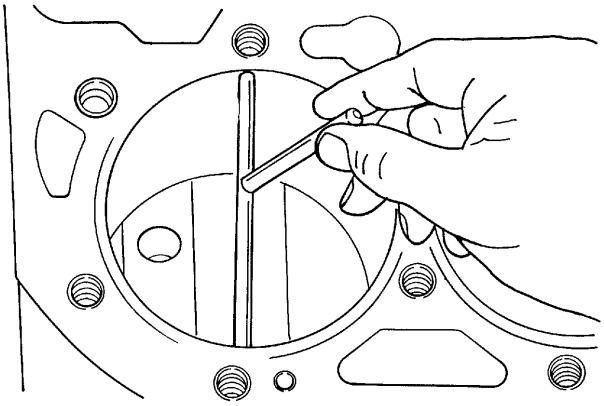
1. Follow hone manufacturer's recommendations for use of hone and cleaning and lubrication during honing.
2. Occasionally, during the honing operation, thoroughly clean cylinder bore and check piston for correct fit in cylinder.
3. When finish-honing a cylinder bore to fit a piston, move hone up and down at a sufficient speed to obtain very fine uniform surface finish marks in a crosshatch pattern of approximately 30 degrees to cylinder bore. Finish marks should be clean but not sharp, free from imbedded particles and torn or folded metal.
4. Permanently mark piston (for cylinder to which it has been fitted) and proceed to hone cylinders and fit remaining pistons.

IMPORTANT: Handle pistons with care and do not attempt to force them through cylinder until cylinder is honed to correct size, as this type piston can be distorted by careless handling.

5. Thoroughly clean cylinder bores with hot water and detergent. Scrub well with a stiff bristle brush and rinse thoroughly with hot water. It is extremely essential that a good cleaning operation be performed. If any abrasive material remains in cylinder bores, it will rapidly wear new rings and cylinder bores in addition to bearings lubricated by the contaminated oil. Swab bores several times with light engine oil on a clean cloth, then wipe with a clean dry cloth. Cylinder should not be cleaned with kerosene or gasoline. Clean remainder of cylinder block to remove excess material spread during honing operation.

PISTON SELECTION

1. Check used piston to cylinder bore clearance as follows:
   a. Measure cylinder bore diameter with a telescope gauge 2-1/2 in. (64 mm) from top of cylinder bore as follows.



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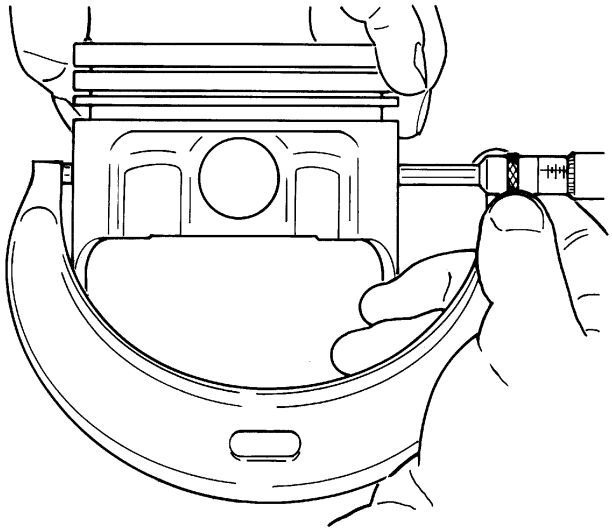
   b. Measure piston diameter at skirt across center line of piston pin as shown.



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   c. Subtract piston diameter from cylinder bore diameter to determine piston-to-bore clearance.
   d. Determine if piston-to-bore clearance is in acceptable range shown in “Specifications.”
2. If used piston is not satisfactory, determine if a new piston can be selected to fit cylinder bore within acceptable range.
3. If cylinder bore must be reconditioned, measure new piston diameter (across centerline of piston pin), then hone cylinder bore to correct clearance (preferable range).
4. Mark piston to identify cylinder for which it was fitted.

Oil Filter By-Pass Valve and Adaptor

⚠CAUTION

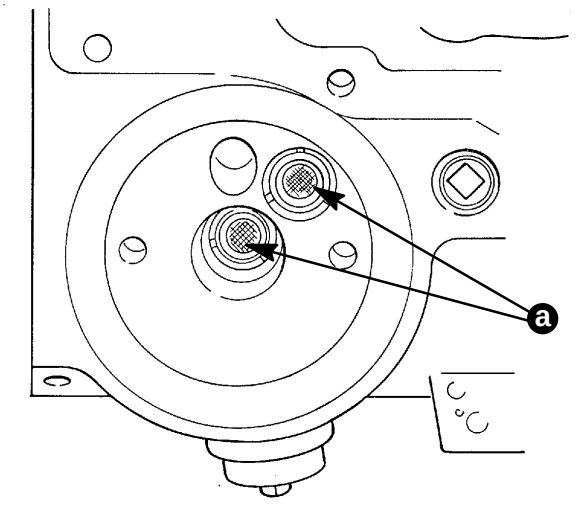
Any Gen V or Gen VI engine with front mounted vertical oil cooler MUST have a 30 PSI oil pressure relief valve installed. Severe engine damage or failure will occur if not installed.

Inspection and/or Replacement

Oil by-pass valve and adaptor should be inspected whenever engine is disassembled for major repair or whenever inadequate oil filtration is suspected.

Refer to “Engine Parts List” when ordering parts for oil filter by-pass valve, adaptor assembly or remote oil filter parts.

1. Remove oil hoses from adaptor.
2. Remove hose fitting and seal from adaptor.
3. Remove connector.
4. Clean parts in solvent and blow dry with compressed air.
5. Inspect fiber valves for cracks or other damage. Check that valves fit tightly against seats. Push each valve down and release it. Valves should return freely to their seats. If valve operation is questionable, by-pass valve should be replaced.



72546

Typical By-Pass Valve and Adaptor

a - Fiber Valves (Ensure That Valves Fit Tightly Against Their Seals

6. Wipe out valve chamber in cylinder block to remove any foreign material.
7. Install by-pass valve (if replaced) and connector. Torque adaptor nut to 20 lb. ft. (27 N·m).
8. Lubricate adaptor seal with engine oil. Install hose fitting and torque to specifications.
9. Apply Perfect Seal to hose threads. Install and tighten securely.

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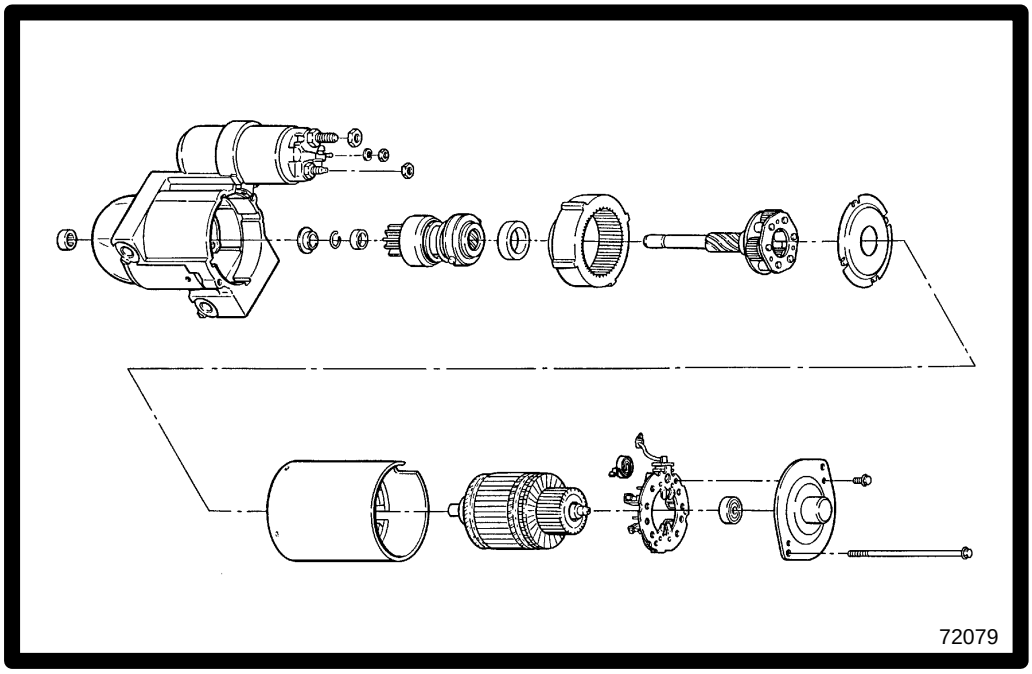
ELECTRICAL SYSTEMS

4

A



STARTING SYSTEM

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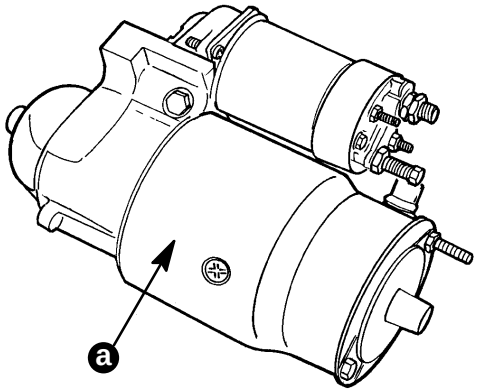
NOTICE

For information and procedures on trouble-shooting, refer to Section 1C.

Identification

The starter identification number is located as shown.



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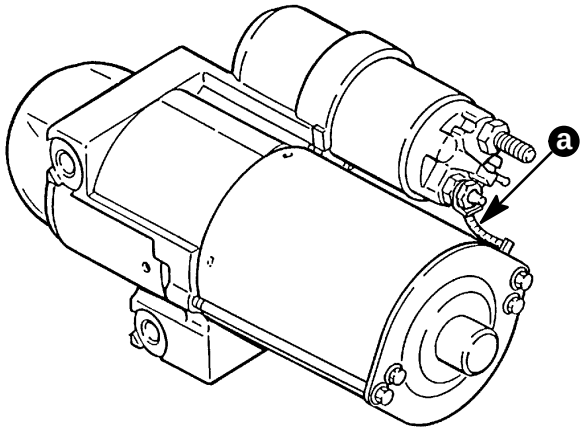
Direct Drive Starter Motor



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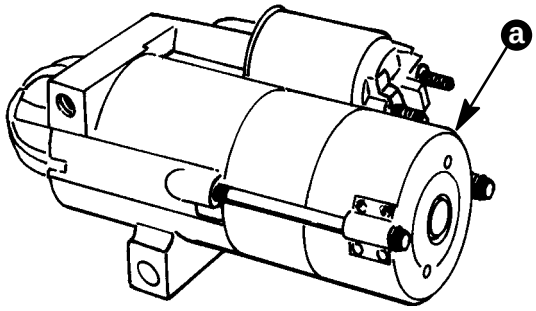
Permanent Magnet Gear Reduction (PG200 and PG250) Starter Motor



Permanent Magnet Gear Reduction (PG260) Starter Motor

a - Starter Identification Number

Replacement Parts Warning

⚠ WARNING

Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

Battery

IMPORTANT: Terminals must be soldered to cable ends to ensure good electrical contact. Use electrical grade (resin flux) solder only. Do not use acid flux solder, as it may cause corrosion and failure.

Battery Cable Recommendations

Cable Length	Cable Gauge	
Up to 3-1/2 Ft. (1.1 m)	4	(25 mm^2)
3-1/2 - 6 Ft (1.1-1.8 m)	2	(35 mm^2)
6 - 7-1/2 Ft. (1.8-2.3 m)	1	(50 mm^2)
7-1/2 - 9-1/2 Ft. (2.3-2.9 m)	0	(50 mm^2)
9-1/2 - 12 Ft. (2.9-3.7 m)	00	(70 mm^2)
12 - 15 Ft. (3.7-4.6 m)	000	(95 mm^2)
15 - 19 Ft. (4.6-5.8 m)	0000	(120 mm^2)
Both positive (+) and negative (–) cables		

Torque Specifications

Fastener Location	lb. ft.	N·m
Starter Mounting Bolts	30	41
All Other Fasteners	Tighten Securely	

Lubricants/Sealants

Description	Part Number
Quicksilver Liquid Neoprene	92-25711-2
Quicksilver 2 4 C Marine Lubricant With Teflon	92-825407A3

Direct Drive Starter Motor

Specifications

Delco Identification Number	Engine Rotation	No Load Test					Brush Spring Tension Oz. (Grams)
		Volts	Min. Amps	Max. Amps	Min RPM	Max. RPM	
10455602	LH	10.6	70	120	5400	10800	56-105 (1588-2976)
Pinion Clearance		.010-.140 (0.25-3.5 mm)					
Commutator End Frame Gap		.025 Max. (0.6 mm Max.)					

Torque Specifications

Fastener Location	Lb. Ft.	N·m
Starter Motor To Block	50	68
All Other Fasteners	Tighten Securely	

Lubricants/Sealants

Description	Part Number
Quicksilver Liquid Neoprene	92-25711-2
SAE 10W Oil	Obtain Locally
SAE 20W Oil	

Positive Current Flow

This is a general description of the positive current flow, from the battery and through the system until the starter motor cranks.

- **Battery to the solenoid switch (on starter) (RED battery cable).**
- **Solenoid switch to circuit breaker (RED).**
- **Circuit breaker to wire junction (RED-PUR).**
- **Wire junction to wiring harness plug (RED-PUR) terminal 6.**
- **Wiring harness plug to 20 amp fuse (RED-PUR).**
- **20 amp fuse to ignition switch terminal I (RED-PUR). At this point ignition switch is turned to START.**
- **Ignition switch terminal B to terminal S.**
- **Ignition switch terminal S to neutral start switch (YEL-RED). NEUTRAL START SWITCH MUST BE AT NEUTRAL POSITION.**
- **Neutral start switch to wiring harness plug terminal 7 (YEL-RED).**
- **Wiring harness plug to starter solenoid (small terminal) (YEL-RED). Also ensure that black (small terminal) wire is grounded.**
- **Starter solenoid is now "closed," completing circuit between large terminal (RED-PUR) and other large terminal (YEL-RED), causing starter motor to crank.**

⚠CAUTION

The starter motor is designed to operate under great overload and produce a high horsepower for its size. It can do this only for a short time, since considerable heat accumulates and can cause serious damage. For this reason, the cranking motor must never be used for more than 30 seconds at any one time. Cranking should not be repeated without a pause of at least 2 minutes to permit the heat to escape.

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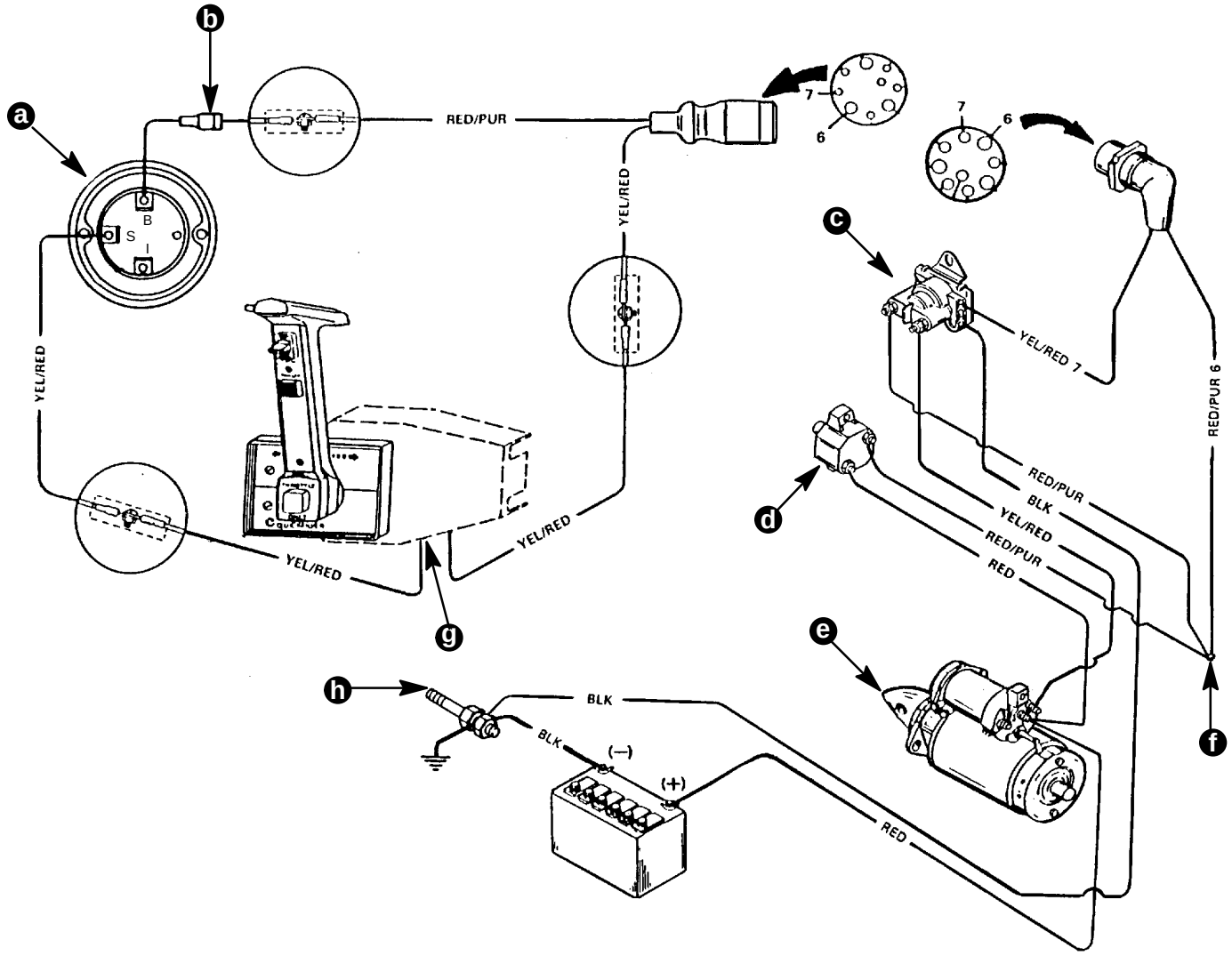
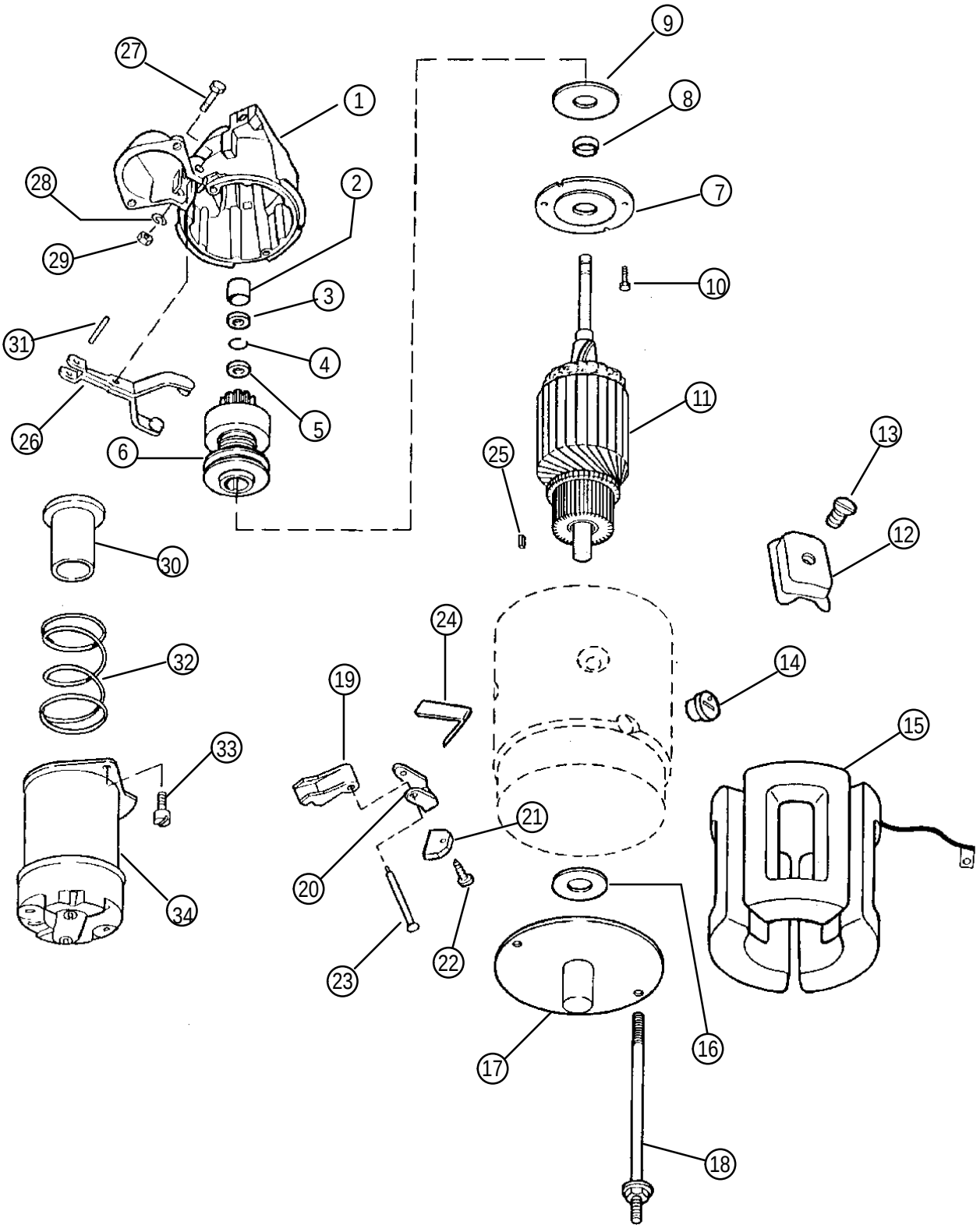
Starting System Components



72930

a - Ignition Switch
b - 20 Amp Fuse
c - Starter Slave Solenoid
d - Circuit Breaker
e - Starter Motor
f - Wire Junction
g - Neutral Safety Switch

Starter Motor (Exploded View)



1 - End Housing
2 - End Housing Bushing
3 - Thrust Collar
4 - Retaining Ring - Pinion Stop Collar
5 - Pinion Stop Collar
6 - Clutch Drive Assembly
7 - Bearing Plate
8 - Bearing Plate Bushing
9 - Bearing Plate Washer
10 - Bearing Plate Screw
11 - Armature
12 - Pole Shoe - Field Coil
13 - Pole Shoe - Field Coil Screw
14 - Field Coil Grommet - Field Frame
15 - Field Coil Assembly
16 - Leather Washer - Commutator End Frame
17 - Lower Commutator End Frame
18 - Thru Bolt
19 - Insulator Holder - Field Frame Brush
20 - Field Frame Brush - Ground Brush
21 - Field Frame Brush
22 - Brush Lead Screw
23 - Ground And Insulated Holders Support Package
24 - Field Frame Brush Spring
25 - Dowel Pin - Field Frame
26 - Shift Lever
27 - Shift Lever Stud
28 - Shift Lever Stud Washer
29 - Shift Lever Stud Nut
30 - Shift Lever Plunger
31 - Plunger To Shift Lever Pin
32 - Plunger Return Spring
33 - Solenoid Switch Screw
34 - Solenoid Switch Assembly

Periodic Inspection

Cranking motor and solenoid are completely enclosed in the drive housing to prevent entrance of moisture and dirt. However, periodic inspection is required as follows:

1. Inspect terminals for corrosion and loose connections.
2. Inspect wiring for frayed and worn insulation.
3. Check mounting bolts for tightness.

Starter Motor Repair

Removal

⚠WARNING

Disconnect battery cables at battery before removing starter.

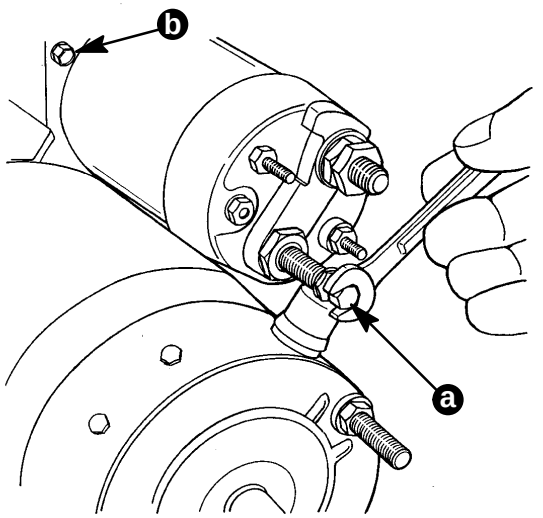
1. Disconnect battery cables from battery.
2. Disconnect wires from solenoid terminals.
3. Remove starter mounting bolts.
4. Pull starter assembly away from flywheel and remove from engine.

Solenoid Switch

REMOVAL

1. Remove starter motor as outlined.
2. Remove screw from field coil connector and solenoid attaching screws.

3. Twist solenoid to disengage tab, and remove.



72631

a - Field Coil Screws
b - Attaching Screws

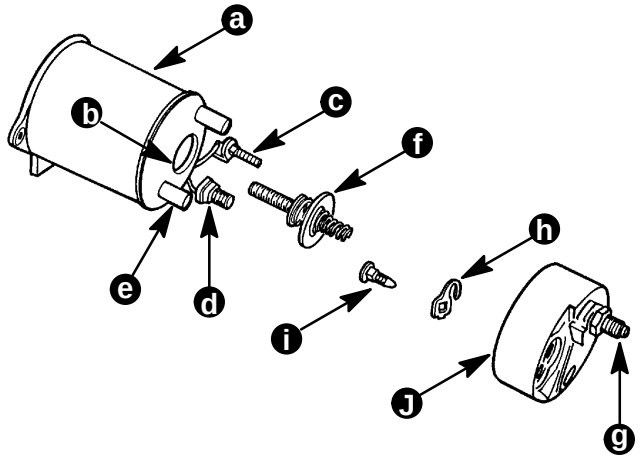
REPLACEMENT OF CONTACTS

1. With solenoid removed from motor, remove nuts and washers from switch terminal S and starter motor connector strap terminal.

2. Remove solenoid end cover retaining screws and washers and remove end cover from solenoid body.

3. Remove nut and washer from battery terminal on end cover and remove battery terminal.

IMPORTANT: DO NOT cut starter motor connector strap terminal wire (to remove terminal) or wire will be too short.



72632

a - Solenoid Body
b - To Hold In Coil
c - Switch Terminal
d - Motor Connector Strap Terminal
e - To Pull In Coil
f - Contact Ring and Push Rod Assembly
g - Battery Terminal
h - Contact Finger
i - Screw
j - End Cover

4. Remove motor connector strap terminal and solder new terminal in position.

5. Remove and install new battery terminal, washer and retaining nut to end cover.

6. Place new contact ring and push rod assembly in solenoid housing.

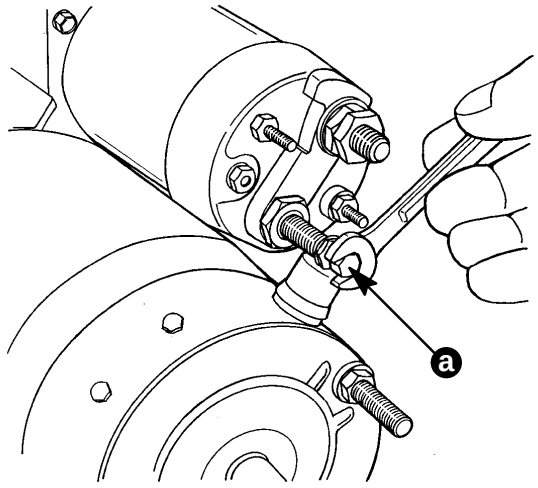
7. Position end cover over switch and motor terminals and install end cover retaining screws. Also install washers and nuts on solenoid switch and starting motor terminals.

INSTALLATION

1. Install solenoid onto plunger.
2. Twist solenoid to engage tab.
3. Install screws and tighten securely.
4. Install field coil connector screw.

Starter Motor Disassembly

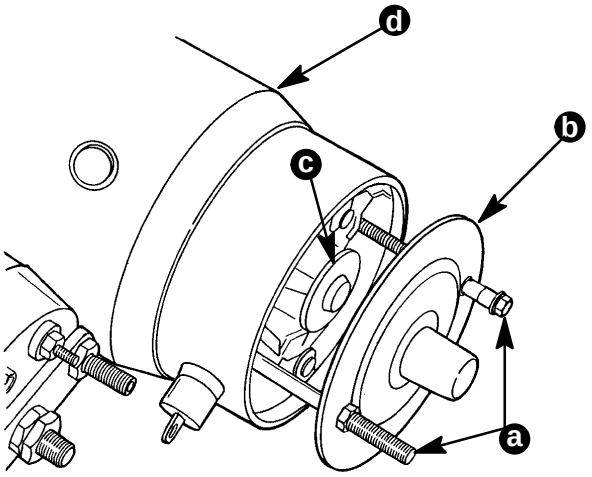
1. Remove screw from field coil connector.



72631

a - Connector Screw

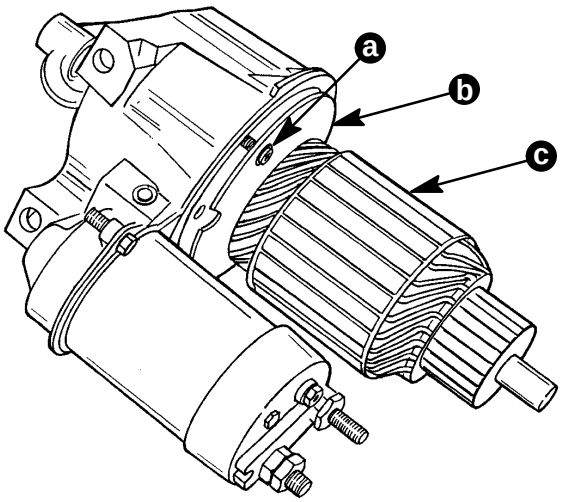
2. Remove end frame thru bolts, end frame, washer and field frame.



72633

a - Thru Bolt
b - End Frame
c - Washer
d - Field Frame

3. Remove screws, center bearing plate and armature.



72634

a - Screws
b - Bearing Plate
c - Armature

4. Slide thrust collar off armature shaft.
5. Drive retainer ring toward armature.
6. Remove snap ring, retainer and clutch assembly.

Cleaning and Inspection

With starting motor completely disassembled, except for removal of field coils, component parts should be cleaned and inspected. Field coils should be removed only where defects are indicated by tests. Defective parts should be replaced or repaired.

IMPORTANT: DO NOT use grease dissolving solvents for cleaning over-running clutch, armature and field coils. Such a solvent would dissolve grease packed in clutch mechanism and damage armature and field coil insulation.

1. Test over-running clutch action. Pinion should turn freely in over-running direction and must not slip in cranking direction. Check pinion teeth. Check spring for tension and drive collar for wear. Replace if necessary.

2. Check that brush holders are not damaged or bent and will hold brushes against commutator.

3. Check brushes. Replace if pitted or worn to one-half their original length [5/16 in. (8 mm) or less].

4. Check fit of armature shaft in bushing of drive housing. Shaft should fit snugly. Replace bushing, if worn. Apply SAE 20 oil to bushing before reassembly. Avoid excessive lubrication.

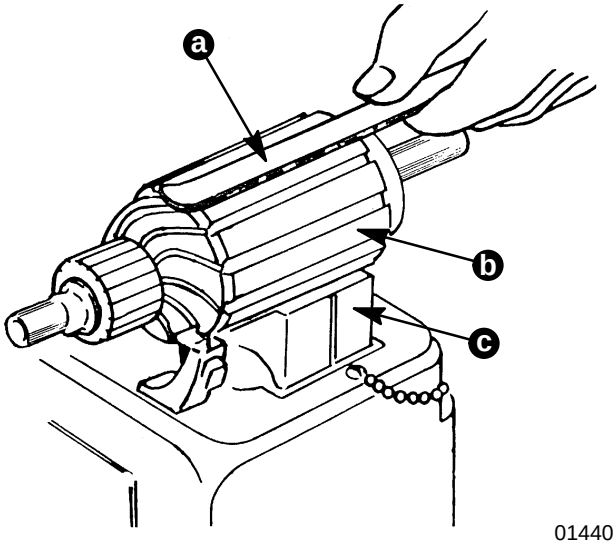
5. Check fit of bushing in commutator end frame. If bushing is damaged or worn excessively, replace end frame assembly. Apply SAE 20 oil to bushing before reassembly. Avoid excessive lubrication.

6. Inspect armature commutator. If rough or out-of-round, turn down and undercut. Inspect points (where armature conductors join commutator bars) for good, firm connection. Burned commutator bar usually is evidence of poor connection.

Armature Tests

TEST FOR SHORTS

Check armature for shorts by placing on growler and holding hack saw blade over armature core while rotating armature. If saw blade vibrates, armature is shorted. After cleaning between commutator bars, recheck. If saw blade still vibrates, replace armature.



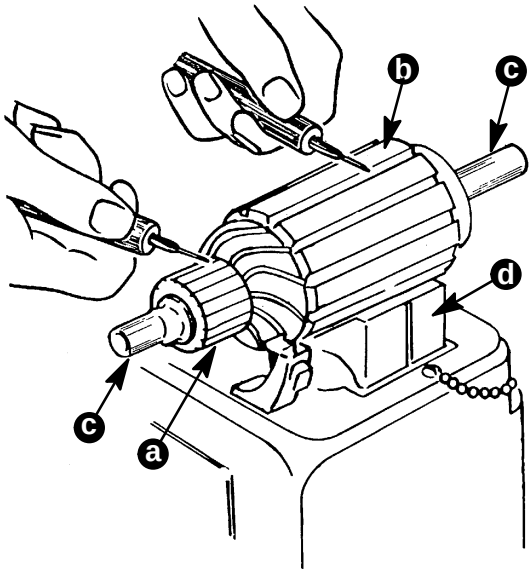
01440

a - Hacksaw Blade
b - Armature Core
c - Growler

TEST FOR GROUND

1. With continuity meter, place one lead on armature core or shaft and other lead on commutator.

2. If meter hand moves, armature is grounded and must be replaced.



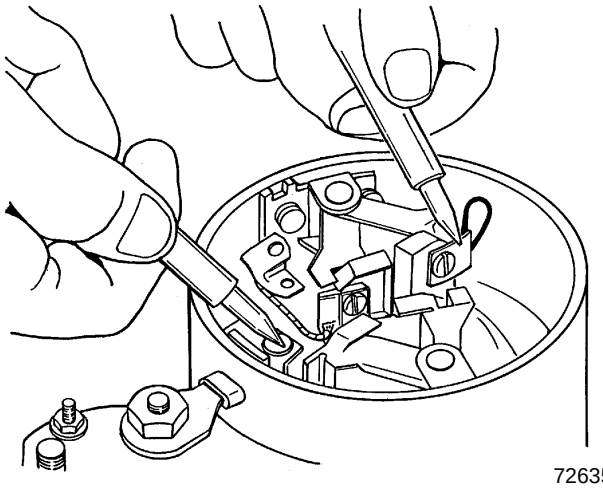
01441

a - Commutator
b - Armature Core
c - Shaft
d - Growler

Field Coil Tests

TEST FOR OPEN CIRCUIT

1. With continuity meter, place one lead on each end of field coils (insulated brush and field connector bar).



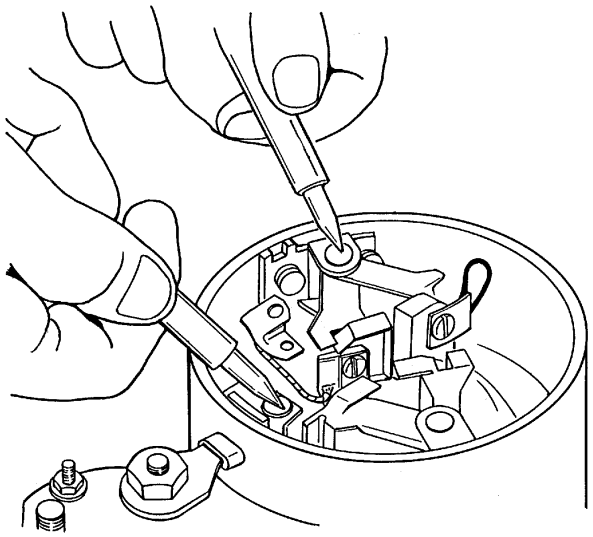
72635

2. If meter does not move, field coils are open and must be replaced.

TEST FOR GROUND

IMPORTANT: Be sure that positive brushes and leads do not contact field frame assembly during test, or false reading will result.

1. With continuity meter, place one lead on field connector bar and other lead on grounded brush.



72636

2. If meter hand moves, field coils are grounded and must be replaced.

Loose Electrical Connections

If open soldered connection of armature to commutator leads is found during inspection, resolder with resin flux.

IMPORTANT: Never use acid flux on electrical connections.

Turning the Commutator

When inspection shows commutator roughness, clean as follows:

1. Turn down commutator in a lathe until thoroughly cleaned.

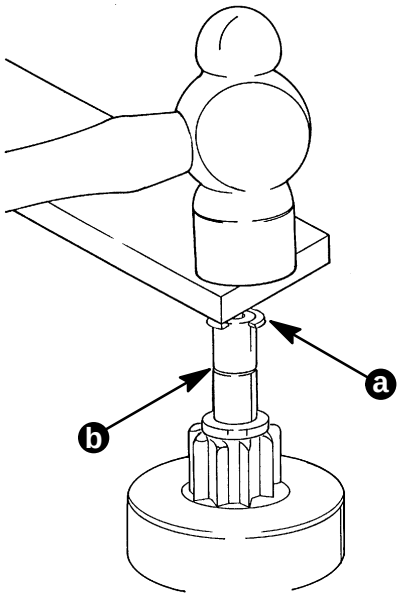
2. Recheck armature for shorts as outlined.

Reassembly

After all parts are thoroughly tested and inspected and worn or damaged parts replaced, reassemble starter as follows:

1. Assemble brushes and related parts to field frame as follows:
   a. Assemble brushes to brush holders. Attach ground wire to grounded brush and field lead wire to insulated brush.
   b. Assemble insulated and grounded brush holders together with V-spring. Position as a unit and install support pin. Push holders and spring to bottom of support and rotate spring to engage center of V-spring in slot in support.

2. Assemble over-running clutch assembly to armature shaft as follows:
   a. Lubricate drive end of armature shaft with SAE 10W oil.
   b. Slide assist spring and clutch assembly onto armature shaft with pinion outward.
   c. Slide retainer onto shaft with cupped surface facing end of shaft (away from pinion).
   d. Drive snap ring onto shaft and slide down into groove.



72073

a - Snap Ring
b - Groove

   e. Assemble thrust collar on shaft with shoulder next to snap ring.
   f. Place thrust collar and retainer next to snap ring and using two pliers squeeze both until snap ring is forced into retainer.

3. Place 4 or 5 drops of light engine oil in drive housing bushing. Slide armature and clutch assembly into place while engaging shift lever with clutch.

4. Position field frame over armature and apply Quicksilver Liquid Neoprene between frame against drive housing, observing caution to prevent damage to brushes.

5. Place 4 to 5 drops of light engine oil in bushing in commutator end frame. Place brake washer and commutator end frame onto shaft.

6. Install solenoid return spring on plunger.

7. Position solenoid assembly to starter motor end frame and turn solenoid to engage flange in slot.

8. Install (and tighten securely) screws which hold solenoid assembly to end frame.

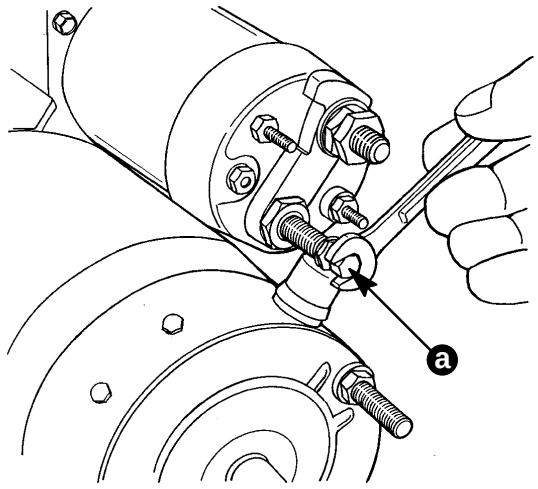
9. Secure starter motor connector strap terminal with screw and washer.

Clearances

PINION CLEARANCE

Pinion clearance must be checked as follows after reassembly of motor to insure proper adjustment.

1. Disconnect motor field coil connector from solenoid motor terminal and insulate it carefully.

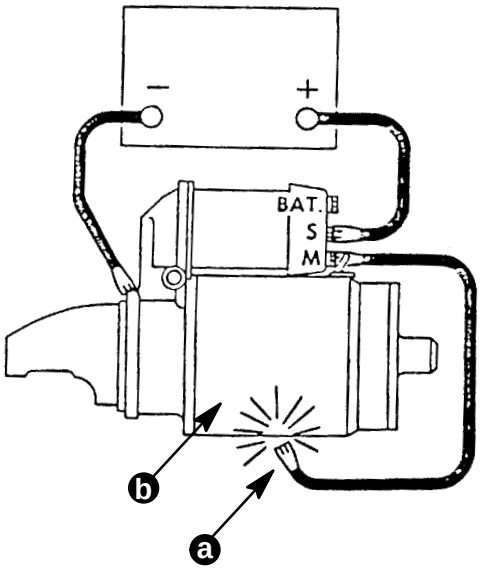


72631

a - Motor Field Coil Connector

2. Connect 12 volt battery positive (+) lead to solenoid switch and negative (–) lead to solenoid frame.

3. Momentarily touch a jumper lead from solenoid motor terminal M to starter motor frame. This shifts pinion into cranking position where it will remain until battery is disconnected.



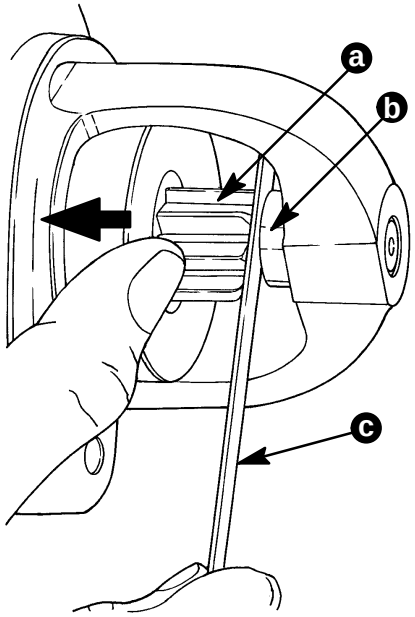
01447

a - Jumper Lead
b - Starter Motor Frame

4. Push pinion back toward commutator end to eliminate slack.

5. Measure distance between pinion and pinion retainer.

6. If clearance is not within limits of .010-.140 in. (0.25-3.5 mm), it may indicate excessive wear of solenoid linkage shift lever yoke buttons or improper assembly of shift lever mechanism. Check for proper assembly, and recheck gap. If still excessive, replace worn or defective parts, since no provision is made for adjusting pinion clearance.



72077

a - Pinion
b - Retainer
c - Feeler Gauge

COMMUTATOR END FRAME GAP

To keep the ignition-proof and safety requirement, the gap between the commutator end frame and field coil housing must be checked. See specifications. If the gap exceeds measurement when checked with a feeler gauge, the end frame should be checked for proper seating on the field coil housing. If properly seated and still found to have excessive gap, the end frame must be replaced.

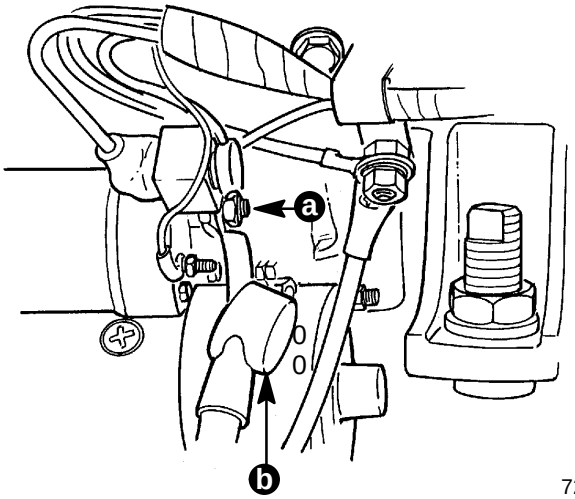
Installation

1. Place starter motor and solenoid assembly in position and install mounting bolts. Torque bolts to 50 lb. ft. (68 N·m).

2. Fasten wires as outlined in wiring diagram.

3. Coat solenoid terminal connections with Quicksilver Liquid Neoprene.

4. Place rubber boot over positive battery cable connection.



72637

a - Positive Battery Cable
b - Rubber Boot

Permanent Magnet Gear Reduction (PG200, PG250 and PG260) Starter Motor

Specifications

PG 200 STARTER MOTOR					
Delco I.D. Number	No Load Test				
	Volts	Min. Amps	Max. Amps	Min. RPMS	Max. RPMS
9000762 9000768	10.6	60	90	3000	3000
Brush Spring Tension	83-104 oz. (2353-2948 g.)				
Pinion Clearance	.010-.160 in. (0.25-4.00 mm)				
Bearing Depth (Gear)	.011-.014 in. (0.28-0.38 mm)				
Bearing Depth (Drive Housing)	.009-.017in. (0.25-0.45 mm)				

PG 250 STARTER MOTOR					
Delco I.D. Number	No Load Test				
	Volts	Min. Amps	Max. Amps	Min. RPMS	Max. RPMS
9000789	10.6	60	95	2750	3250
Brush Spring Tension	83-104 oz. (2353-2948 g.)				
Pinion Clearance	.010-.160 in. (0.25-4.00 mm)				
Bearing Depth (Gear)	.011-.014 in. (0.28-0.38 mm)				
Bearing Depth (Drive Housing)	.009-.017in. (0.25-0.45 mm)				

PG 260 STARTER MOTOR					
Delco I.D. Number	No Load Test				
	Volts	Min. Amps	Max. Amps	Min. RPMS	Max. RPMS
9000789	10.6	60	95	3000	3000
Brush Spring Tension	83-104 oz. (2353-2948 g.)				
Pinion Clearance	.010-.160 in. (0.25-4.00 mm)				
Bearing Depth (Gear)	.011-.014 in. (0.28-0.38 mm)				
Bearing Depth (Drive Housing)	.009-.017in. (0.25-0.45 mm)				

Maintenance

⚠WARNING

DO NOT use jumper cables and a booster battery to start engine. DO NOT recharge a weak battery in the boat. Remove battery and recharge in a well ventilated area away from fuel vapors, sparks or flames.

⚠WARNING

Batteries contain acid which can cause severe burns. Avoid contact with skin, eyes and clothing. Batteries also produce hydrogen and oxygen gases when being charged. This explosive gas escapes fill/vent caps and may form an explosive atmosphere around the battery for several hours after it has been charged; sparks or flames can ignite the gas and cause an explosion which may shatter the battery and could cause blindness or other serious injury.

Safety glasses and rubber gloves are recommended when handling batteries or filling electrolyte. Hydrogen gases that escape from the battery during charging are explosive. When charging batteries, be sure battery compartment, or area where batteries are located, is well vented. Battery electrolyte is a corrosive acid and should be handled with care. If electrolyte is spilled or splashed on any part of the body, immediately flush the exposed area with liberal amounts of water and obtain medical aid as soon as possible.

⚠CAUTION

To prevent damage to the electrical system be sure to adhere to the following:

- **When installing battery, be sure to connect the positive (+) battery cable to positive (+) battery terminal first and then the negative (–) battery cable to negative (–) battery terminal.**
- **Never disconnect the battery cables while the engine is running.**
- **If a charger or booster is to be used, be sure to connect it in parallel with existing battery (positive to positive and negative to negative).**
- **When applying a booster charge to battery, disconnect both cables from battery (to prevent damage to voltage regulator).**
- **Check battery condition periodically.**
- **Make sure that battery leads are kept clean and tight.**

Testing

⚠CAUTION

Test battery in well ventilated area as gases given off by battery are hazardous.

Place battery under heavy load (as during engine cranking or with a variable resistor tester) and test cell voltage while under load.

Certain conditions must be met before testing:

- **Battery must be 60 to 100°F (16 to 38°C).**
- **Electrolyte level must be correct in all cells.**
- **Battery must be at least half charged.**
- **No obvious defects.**

5. Check voltage per manufacturer's specifications.
6. If readings are low, recharge and retest.
7. If readings remain low, battery should be replaced.

Storage

1. Remove battery and clean exterior.
2. Check fluid level and fill if low.
3. Cover terminals and bolts with light coat of grease.
4. Set battery on wood or in carton; store in cool, dry place.
5. Check every 20 days for fluid level and slow charge.

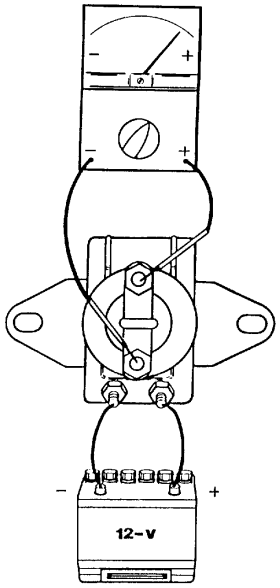
IMPORTANT: A discharged battery can be damaged by freezing.

Index

Standard Starter Slave Solenoid

Testing/Replacement

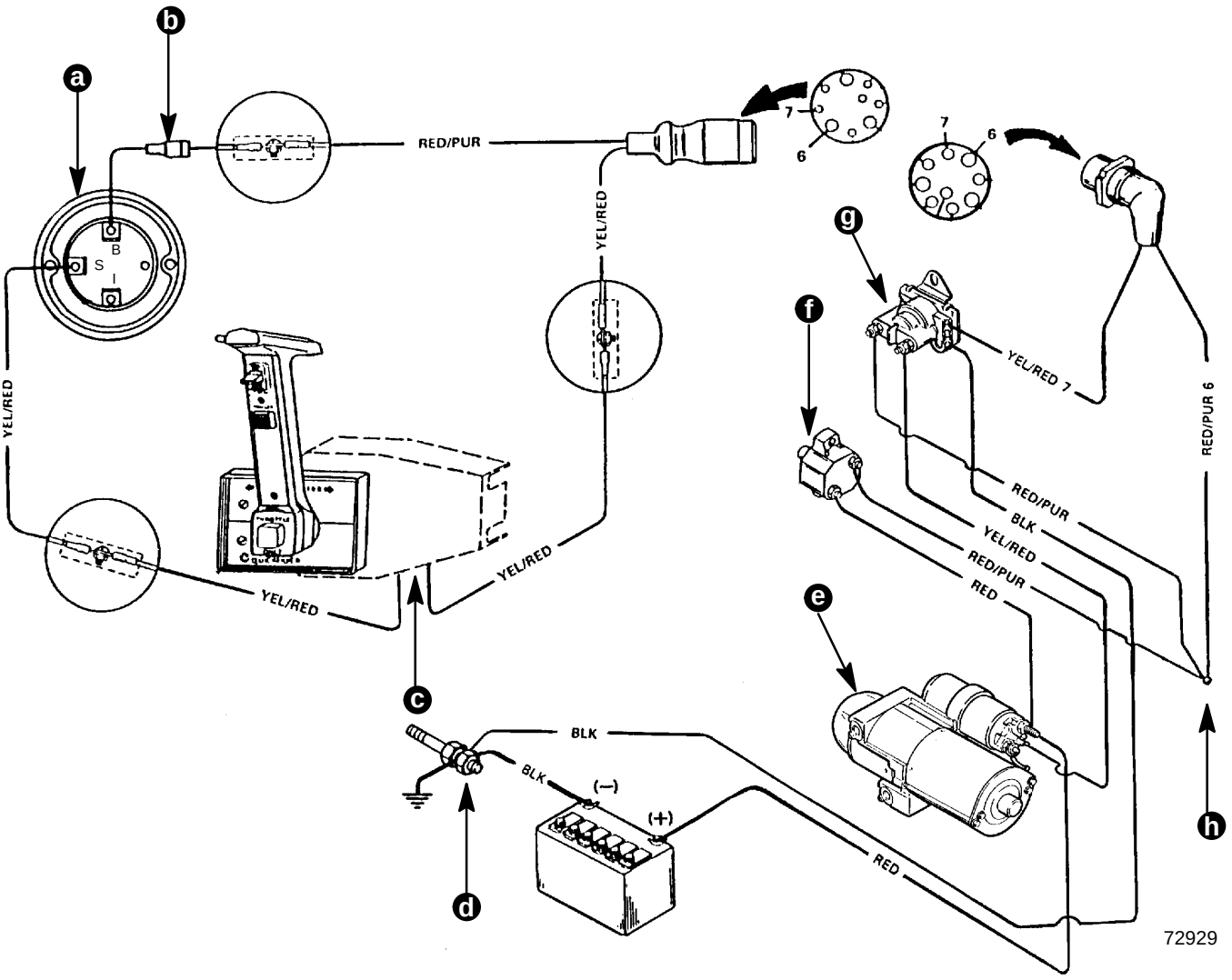
1. Using continuity meter, connect test leads as shown, and connect 12 volt battery with jumper leads as shown.



72630

2. If no meter movement is present, replace solenoid.

Starting System Components



a - ignition Switch
b - 20 Amp. Fuse
c - Neutral Safety Switch
d - Ground Stud
e - Starter Motor
f - Circuit Breaker
g - Starter Slave Solenoid
h - Wire Junction

Positive Current Flow

This is a general description of the positive current flow, from the battery and through the system until the starter motor cranks.

- **Battery to the solenoid switch (on starter) (RED battery cable).**
- **Solenoid switch to circuit breaker (RED).**
- **Circuit breaker to wire junction (RED-PUR).**
- **Wire junction to wiring harness plug (RED-PUR) terminal 6.**
- **Wiring harness plug to 20 amp fuse (RED-PUR).**
- **20 amp fuse to ignition switch terminal I (RED-PUR). At this point ignition switch is turned to START.**
- **Ignition switch terminal B to terminal S.**
- **Ignition switch terminal S to neutral start switch (YEL-RED). NEUTRAL START SWITCH MUST BE AT NEUTRAL POSITION.**
- **Neutral start switch to wiring harness plug terminal 7 (YEL-RED).**
- **Wiring harness plug to starter solenoid (small terminal) (YEL-RED). Also ensure that black (small terminal) wire is grounded.**
- **Starter solenoid is now "closed," completing circuit between large terminal (RED-PUR) and other large terminal (YEL-RED), causing starter motor to crank.**

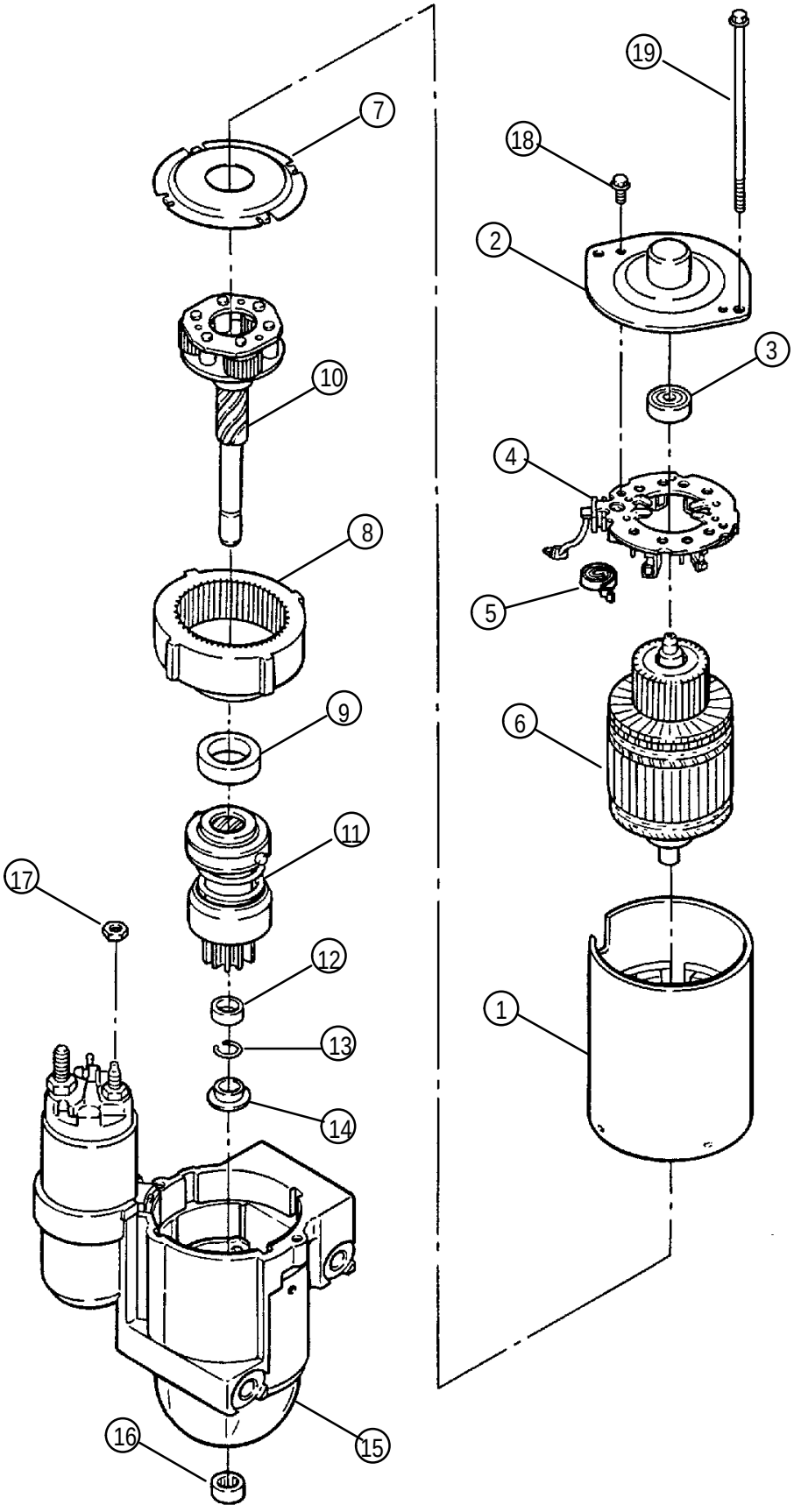
Description

The Permanent Magnet Gear Reduction (PG200 and PG250) starter motors feature small permanent magnets mounted inside the field frame (NOTE: The actual configuration of these magnets differs between the PG200, PG250 and PG260; the field frames with permanent magnets are not interchangeable. Otherwise, the units are similar.) These magnets take the place of current-carrying field coils mounted on iron pole pieces. Internal gear reduction, approximately 4 to 1, through planetary gears results in armature speeds in the 7000 RPM range. The armature and drive shaft are mounted on roller or ball bearings in place of bushings. The solenoid switch, plunger, return spring, and shift lever are permanently mounted in the drive housing.

⚠CAUTION

The starter motor is designed to operate under great overload and produce a high horsepower for its size. It can do this only for a short time, since considerable heat accumulates and can cause serious damage. For this reason, the cranking motor must never be used for more than 30 seconds at any one time. Cranking should not be repeated without a pause of at least 2 minutes to permit the heat to escape.

PG 200 and PG 250 Starter Motor (Exploded View)



72079

1 - Field Frame (with Permanent Magnets)
2 - End Frame
3 - Ball Bearing
4 - Brushes With Frame
5 - Brush Spring
6 - Armature
7 - Shield
8 - Gear
9 - Roller Bearing
10 - Planetary Gear And Shaft Assembly
11 - Drive
12 - Collar
13 - Retaining Ring
14 - Thrust Collar
15 - Drive Housing
16 - Roller Bearing
17 - Nut
18 - Screw
19 - Thru Bolt
* Contains: Starter Solenoid, Plunger, Return Spring and Shift Lever

Solenoid Switch

The solenoid switch, along with plunger, return spring, and shift lever, are completely sealed and permanently mounted in the drive housing. If solenoid is defective, entire drive housing must be replaced.

Periodic Inspection

Cranking motor and solenoid are completely enclosed in the drive housing to prevent entrance of moisture and dirt. However, periodic inspection is required as follows:

1. Inspect terminals for corrosion and loose connections.

2. Inspect wiring for frayed and worn insulation.

3. Check starter mounting bolts for tightness.

PG 200 and PG 250 Starter Motor Repair

Removal

⚠WARNING

Disconnect battery cables at battery before removing starter.

1. Disconnect battery cables from battery.

2. Disconnect wires from solenoid terminals.

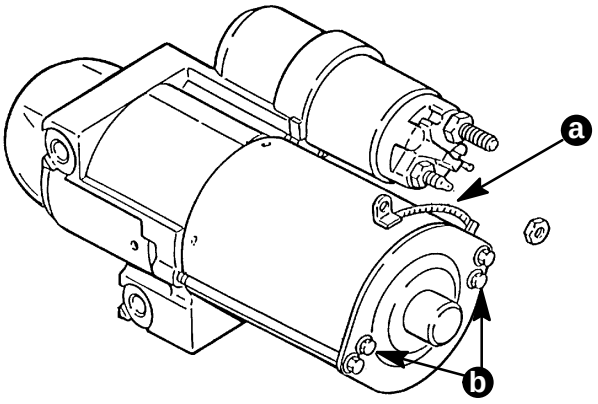
IMPORTANT: Some starter motors may use a special mounting shim for gaining flywheel clearance. Do not lose this shim; it will be needed when remounting starter on engine block.

3. Remove starter mounting bolts.

4. Pull starter assembly away from flywheel and remove from engine.

Disassembly

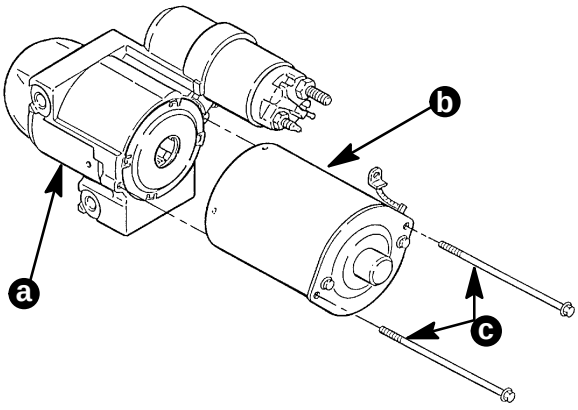
1. Remove brush lead from solenoid and screws from end frame.



72060

a - Brush Lead
b - Screws

2. Remove thru bolts and separate field frame with armature from drive housing.

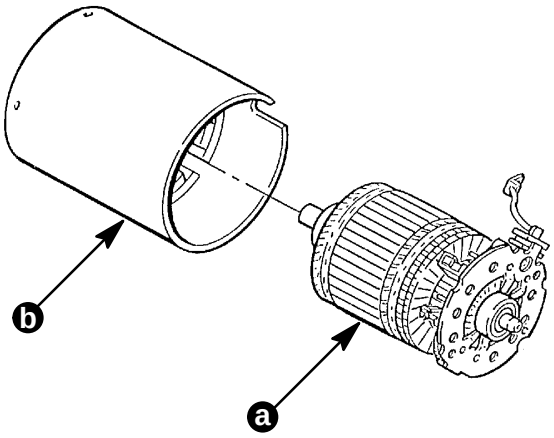


72061

a - Field Frame / Armature
b - Drive Housing
c - Thru Bolts

3. Pull armature out of field frame.

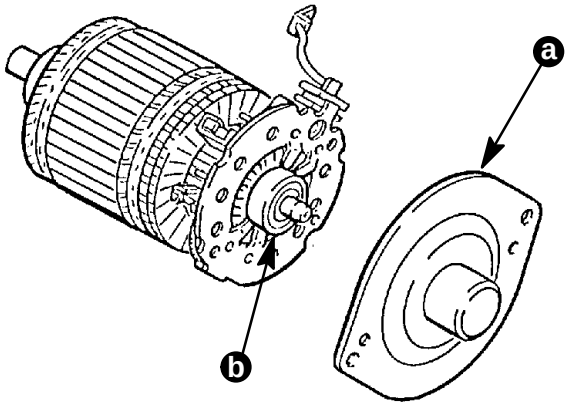
NOTE: *Permanent magnets inside field frame will be holding armature in place.*



72062

a - Armature
b - Field Frame

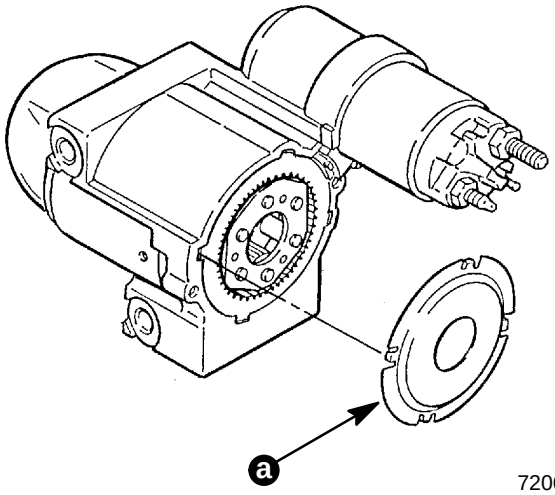
4. Pull end frame off bearing.



72063

a - End Frame
b - Bearing

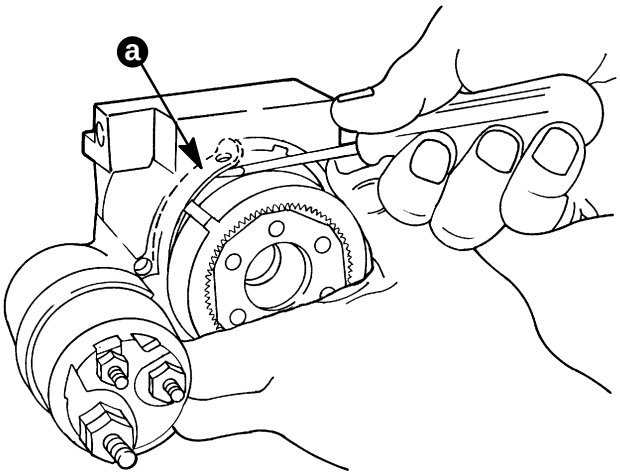
5. Remove shield.



72065

a - Shield

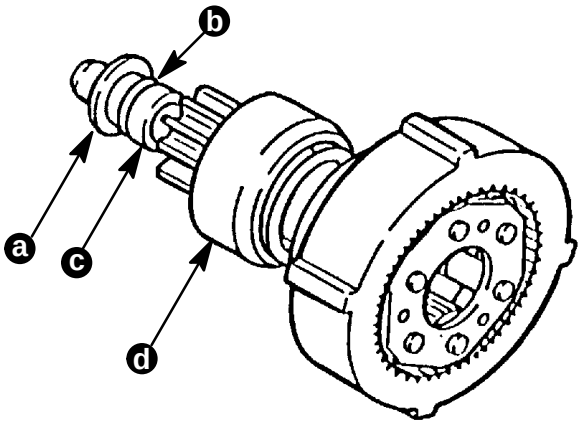
6. Use a screwdriver, as shown, to disengage shift lever from drive.



72064

a - Shift Lever

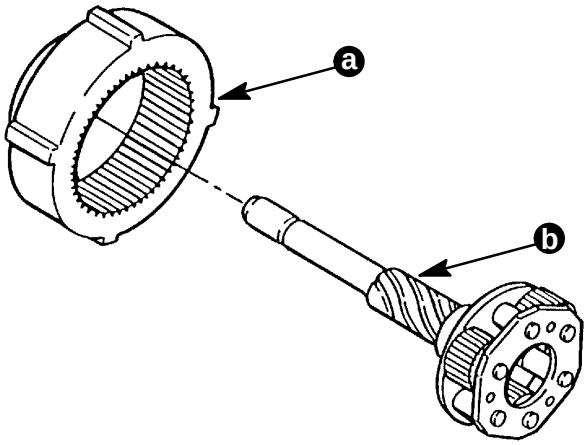
7. Remove thrust collar, retaining ring and collar. Remove drive.



72067

a - Thrust Collar
b - Retaining Ring
c - Collar
d - Drive

8. Remove gear from shaft assembly.



72066

a - Gear
b - Shaft Assembly

Cleaning and Inspection

IMPORTANT: Do not use grease dissolving solvents to clean electrical components, planetary gears, or drive. Solvent will damage insulation and wash the lubricant out of the drive and gears. Use clean rags and compressed air to clean components.

1. Test over-running clutch action of drive. Pinion should turn freely in over-running direction and must not slip in cranking direction. Check pinion teeth. Check spring for tension and drive collar for wear. Replace if necessary.

2. Check that brush holders are not damaged or bent and hold brushes against commutator. Check brushes for wear; refer to “Brushes and Brush Holder.”

3. Inspect armature commutator. If badly grooved or out-of-round, turn down and undercut commutator.

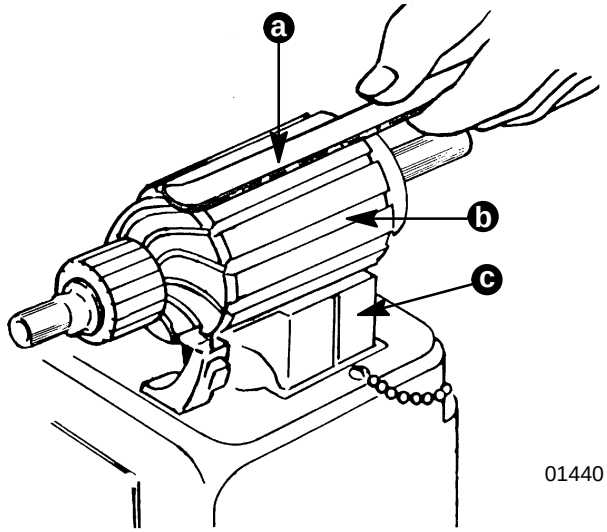
4. Inspect all roller bearing surfaces for wear. Check that bearings roll freely. If any roughness is felt, replace bearings.

5. Inspect planetary gear assembly. Gears must mesh easily and roll freely with no binding.

Armature Tests

TEST FOR SHORTS

Check armature for shorts by placing on growler and holding hack saw blade over armature core while rotating armature. If saw blade vibrates, armature is shorted. After cleaning between commutator bars, recheck. If saw blade still vibrates, replace armature.



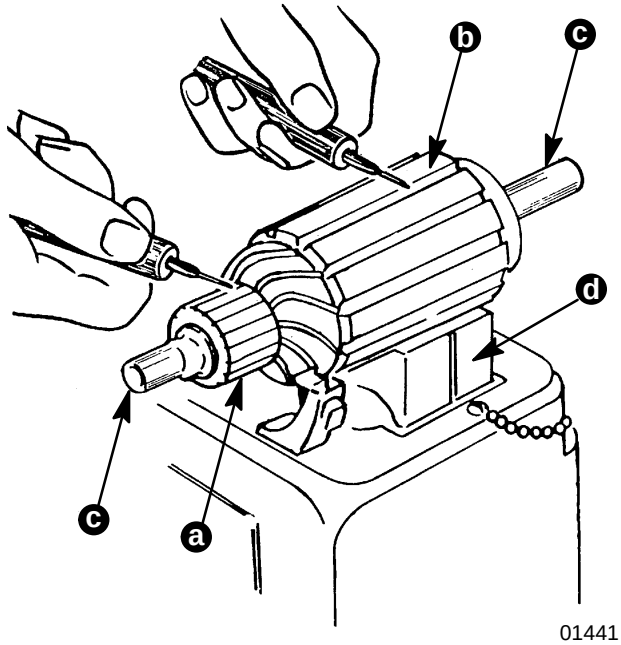
01440

a - Hacksaw Blade
b - Armature Core
c - Growler

TEST FOR GROUND

1. With continuity meter, place one lead on armature core or shaft and other lead on commutator.

2. If meter hand moves, armature is grounded and must be replaced.



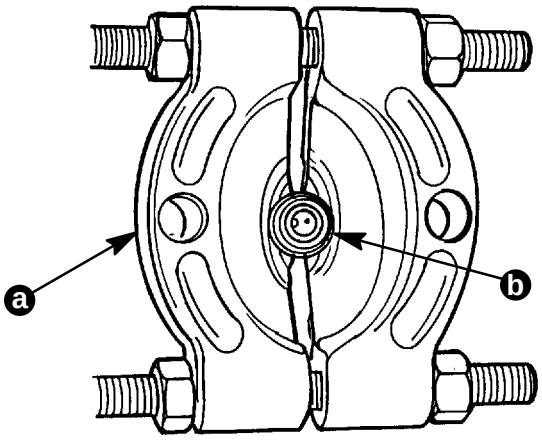
01441

a - Commutator
b - Armature Core
c - Shaft
d - Growler

Armature Bearing (Commutator End)

REMOVAL

Use a universal puller plate, as shown, to remove bearing.



72068

a - Universal Puller Plate
b - Bearing

INSTALLATION

IMPORTANT: Brush holder must be installed on armature before installing armature bearing.

Using the correct size driver, press on inner bearing race until it contacts shoulder of armature shaft.

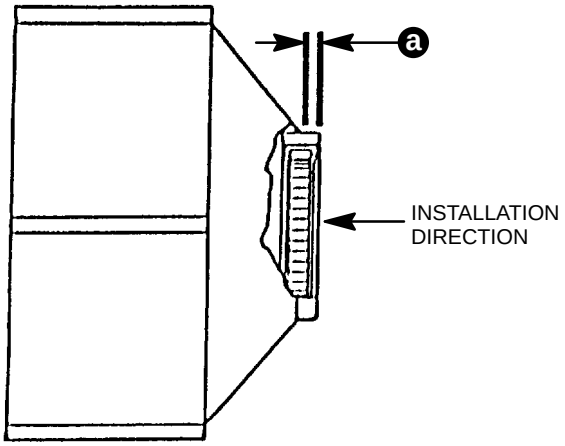
Gear Bearing

REMOVAL

Using the correct size driver, press bearing out of gear.

INSTALLATION

1. Using the correct size driver, press bearing into gear, from direction shown, to depth (a).



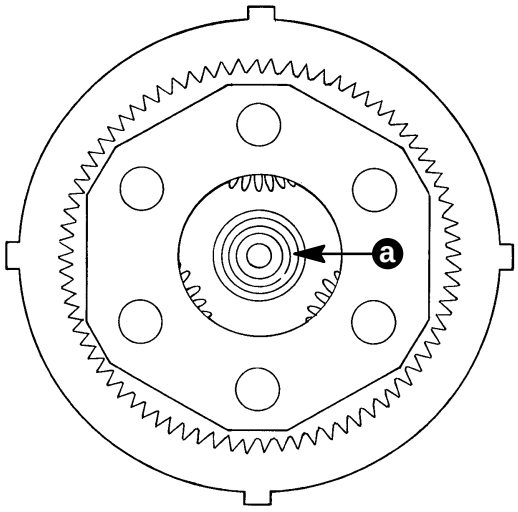
72625

a - See Specifications

2. Lubricate bearing and gear teeth with a small amount of Quicksilver 2-4-C Marine Lubricant.

Shaft Assembly Bearing

IMPORTANT: Roller bearing is not replaceable. If bearing is defective, replace entire shaft assembly. Apply Quicksilver 2-4-C Marine Lubricant to bearing before starter reassembly.



72070

a - Roller Bearing

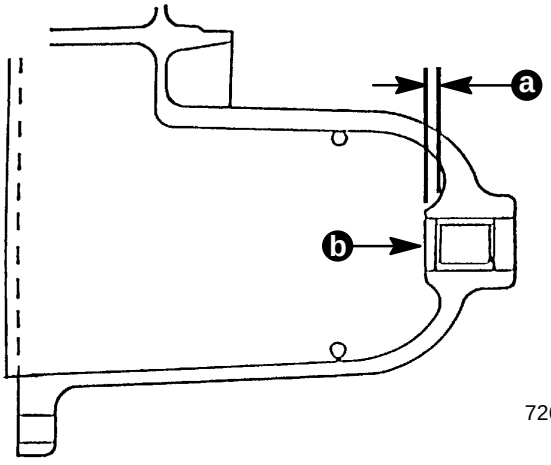
Drive End Housing Bearing

REMOVAL

Using the correct size driver, press bearing out of housing.

INSTALLATION

1. Using the correct size driver, press bearing into housing, from direction shown, to depth (a).



72626

a - See Specifications
b - Installation Direction

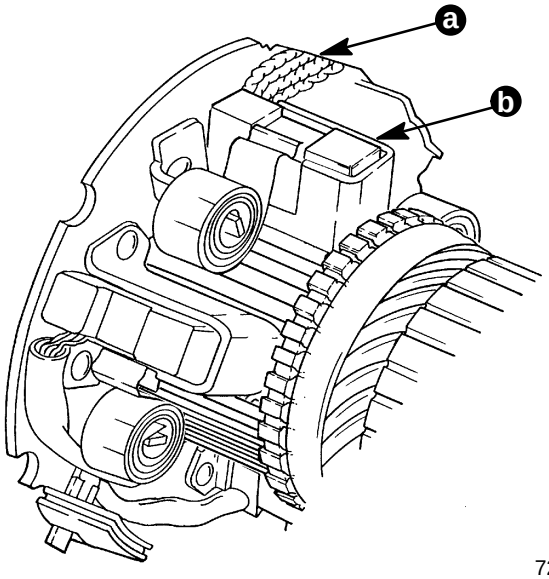
2. Lubricate bearing with a small amount of Quicksilver 2-4-C Marine Lubricant.

Brushes and Brush Holder

INSPECTION

Replace brushes and holder when brush leads are touching guide.

Make sure brushes move freely in guides.



72069

a - Brush Leads
b - Guides

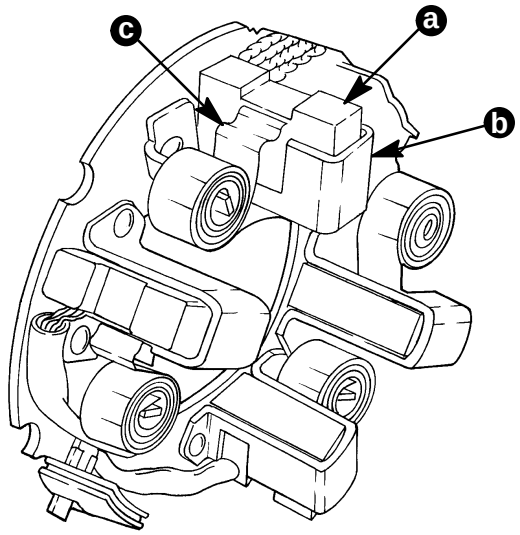
REMOVAL

1. Remove armature bearing as previously described.

2. Remove brush holder.

INSTALLATION

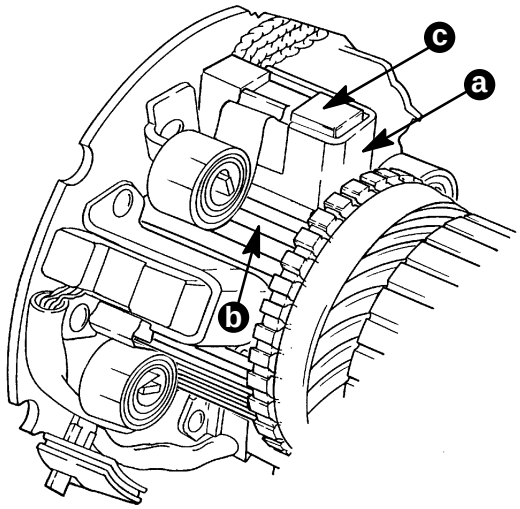
1. Push each brush up into its guide to allow spring to hold it in place, as shown.



72072

a - Brush
b - Guide
c - Brush Spring

2. Place brush holder on armature and push brushes down against commutator, as shown.



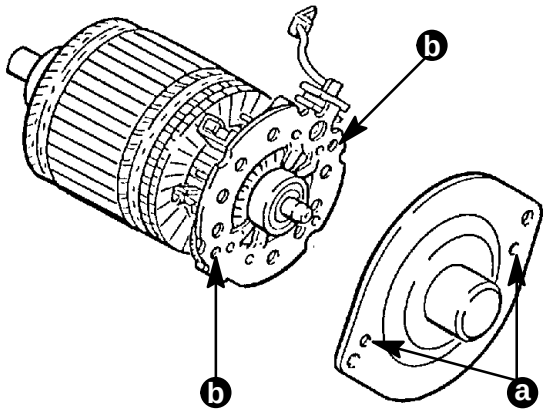
72069

a - Brush Holder
b - Commutator
c - Brush

3. Install armature bearing as previously described.

Reassembly

1. Install end frame on brush holder. Align holes of end frame with holes of brush holder. Tighten screws securely.

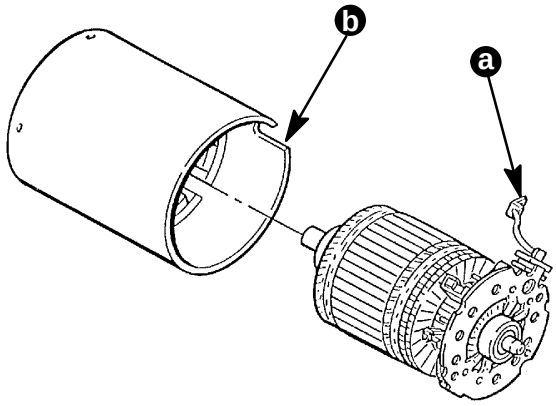


72063

a - Holes Of End Frame
b - Holes Of Brush Holder

2. Insert armature into field frame. Align brush holder lead with notch in field frame.

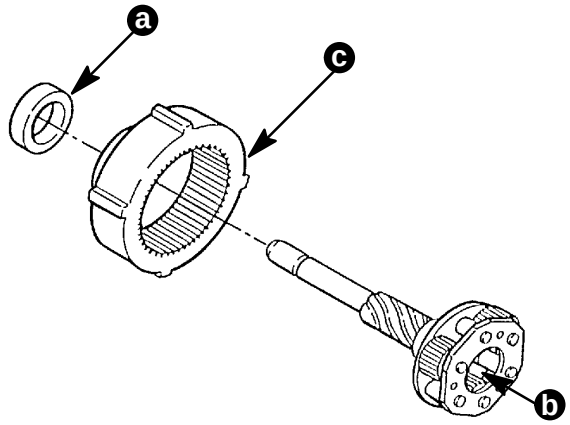
NOTE: *Permanent magnets in field frame will pull armature in place.*



72062

a - Brush Holder Lead
b - Notch

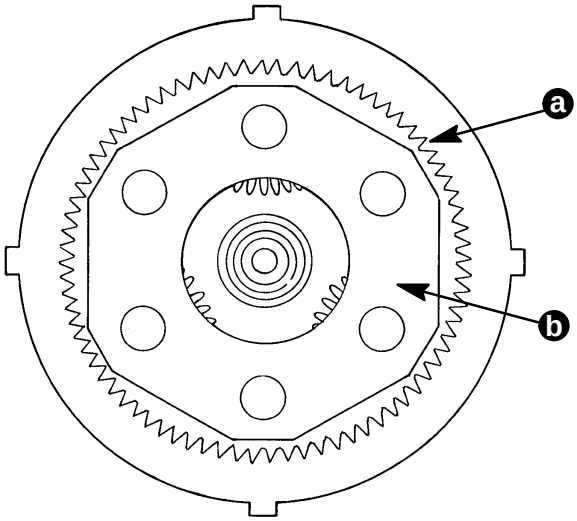
3. Coat roller bearings and gear with a small amount of Quicksilver 2-4-C Marine Lubricant.



72627

a - Roller Bearing
b - Roller Bearing
c - Gear

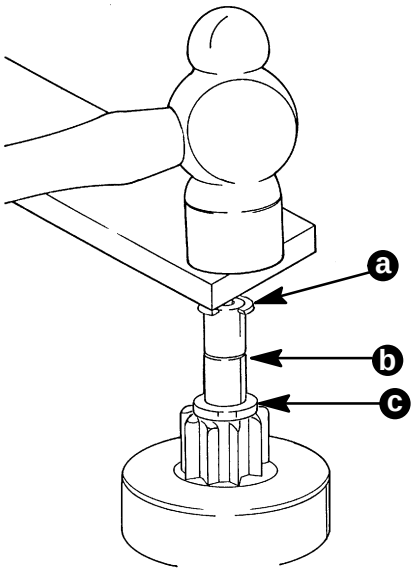
4. Assemble gear and shaft together, as shown.



72070

a - Gear Assembly
b - Shaft Assembly

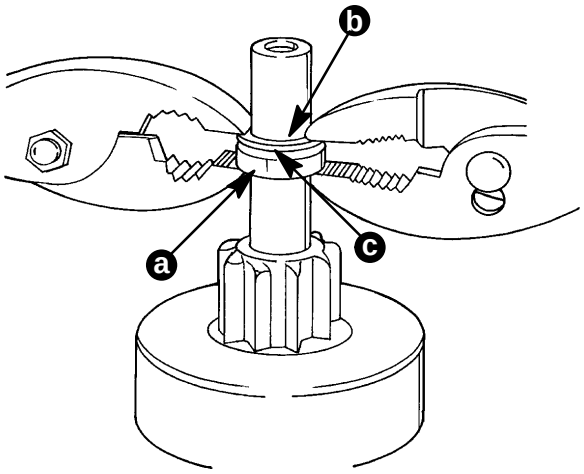
5. Assemble drive on shaft assembly as follows:
   a. Lubricate drive end of shaft assembly with SAE 10W oil.
   b. Slide drive assembly onto shaft with pinion outward.
   c. Slide retainer onto shaft with cupped surface facing end of shaft (away from pinion).
   d. Position snap ring on upper end of shaft and hold in place with block of wood. Strike wood block with hammer, thus forcing snap ring over end of shaft. Slide snap ring down into groove.



72073

a - Snap Ring
b - Groove
c - Retainer

   e. Assemble thrust collar on shaft with shoulder next to snap ring.
   f. Position retainer and thrust collar next to snap ring. Then, using two pliers, grip retainer and thrust collar and squeeze until snap ring is forced into retainer.

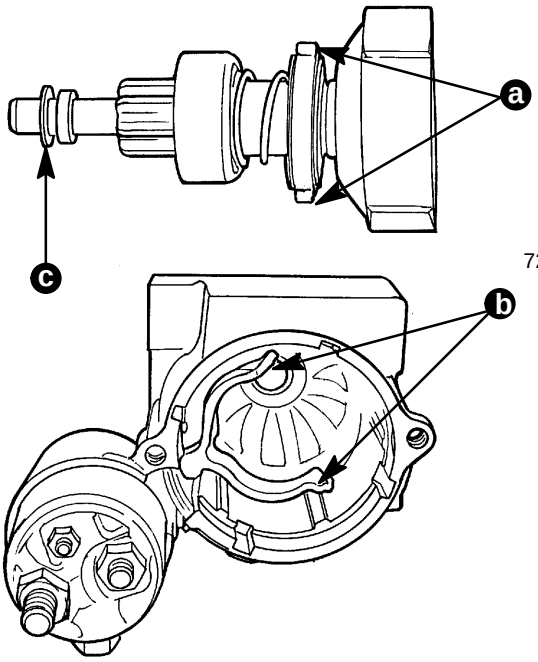


72074

a - Retainer
b - Thrust Collar
c - Snap Ring

6. Apply a thin coating of Quicksilver 2-4-C Marine Lubricant to roller bearing in drive housing.

7. Insert shaft and drive assembly into drive housing. Pins of drive must be snapped into holes of shift lever. Thrust collar must be in place before shaft is inserted in housing roller bearing.

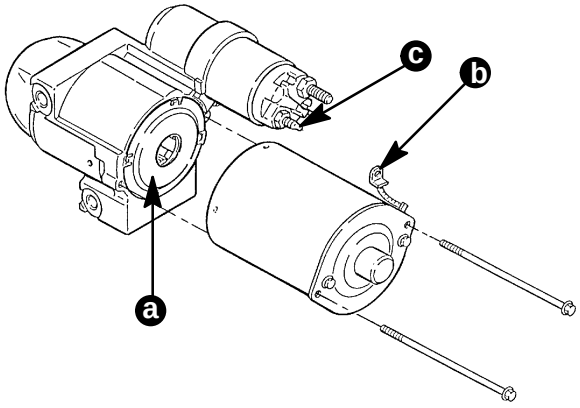


72628

72075

a - Pins Of Drive
b - Holes Of Shift Lever
c - Thrust Collar

8. Install shield. Align brush lead and solenoid terminal when inserting armature into planetary gears.

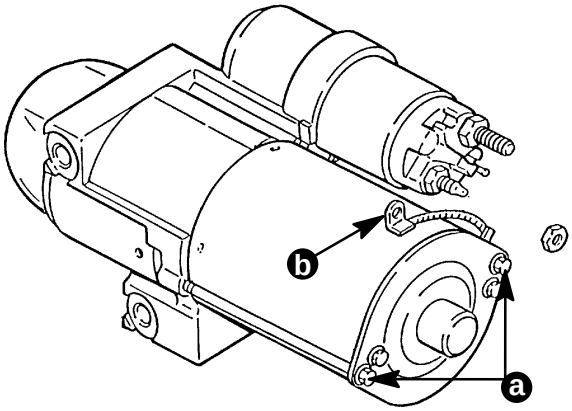


72061

a - Shield
b - Brush Lead
c - Solenoid Terminal

9. Install thru bolts and brush lead. Tighten fasteners securely.

IMPORTANT: Do not overtighten thru bolts. Overtightening will bend end frame.



72060

a - Thru Bolts
b - Brush Lead

Installation

IMPORTANT: Install special mounting shim (if equipped) between starter motor and engine block.

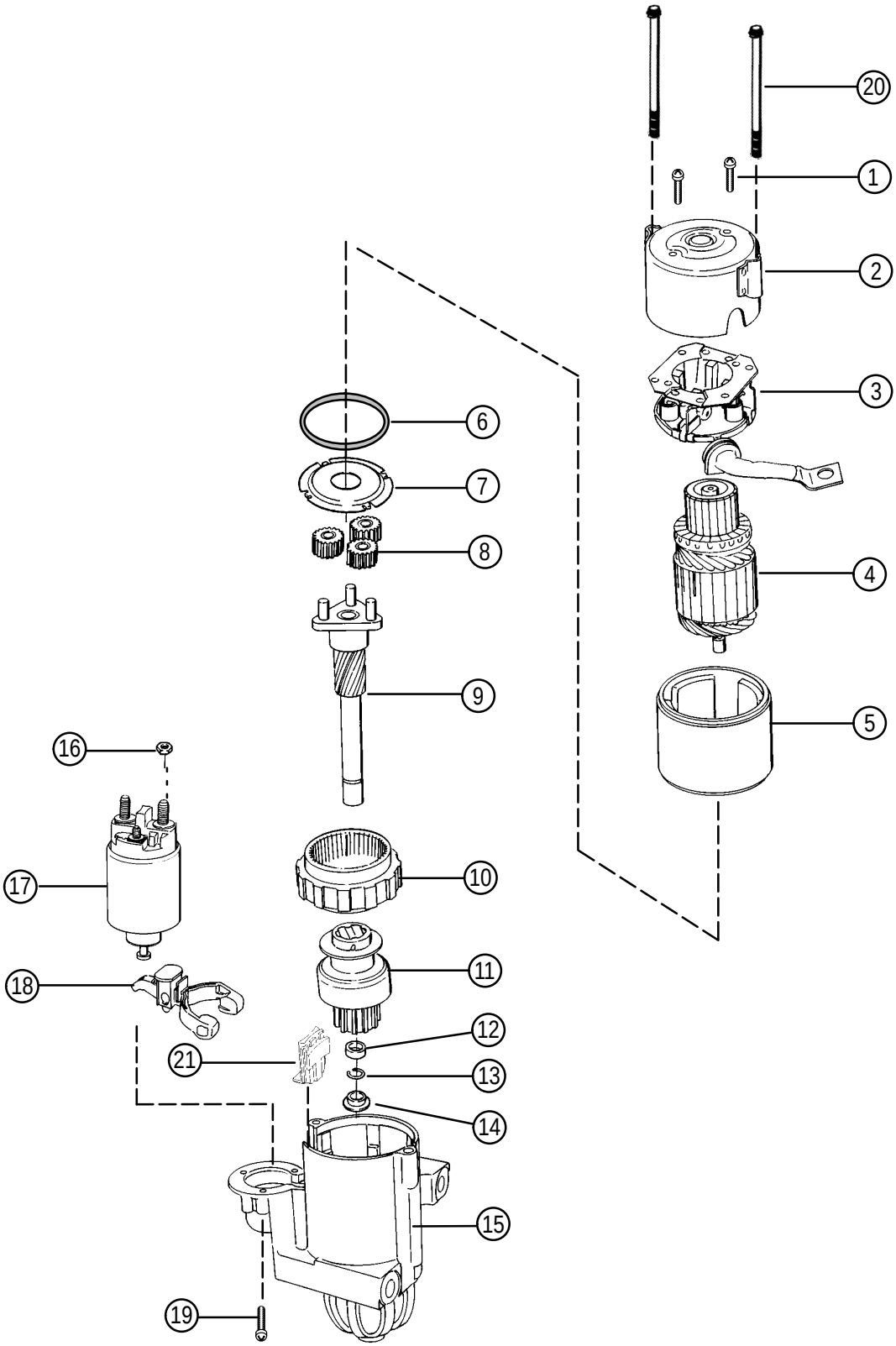
1. Place starter motor in position and install mounting bolts. Torque bolts to 30 lb. ft. (41 N·m).

2. Connect YELLOW/RED wire to terminal S of solenoid. Connect ORANGE wire, RED wire, and battery cable to large terminal of solenoid. Tighten fasteners securely. Coat terminals with Quicksilver Liquid Neoprene. Install battery cable boot, if so equipped.

3. Connect battery cables to battery in the following order. Connect positive (+) cable to positive (+) battery terminal and tighten cable clamp. Then connect negative (–) cable to negative (–) terminal and tighten clamp.

PG 260 Starter Motor

Exploded View



74270

1 - Screw (2)
2 - End Cap
3 - Brush With Holder
4 - Armature
5 - Field Frame (With Permanent Magnets)
6 - Washer
7 - Shield
8 - Planetary Gears
9 - Shaft
10 - Gear
11 - Drive
12 - Collar
13 - Retaining Ring
14 - Trust Collar
15 - Drive Housing
16 - Nut
17 - Solenoid
18 - Solenoid Drive Arm
19 - Screw (3)
20 - Thru Bolt (2)
21 - Rubber Grommet

Solenoid Switch

The solenoid switch can be removed and replaced if defective.

Periodic Inspection

Cranking motor and solenoid are completely enclosed in the drive housing to prevent entrance of moisture and dirt. However, periodic inspection is required as follows:

1. Inspect terminals for corrosion and loose connections.

2. Inspect wiring for frayed and worn insulation.

3. Check starter mounting bolts for tightness.

PG 260 Starter Motor Repair

Removal

⚠WARNING

Disconnect battery cables at battery before removing starter.

1. Disconnect battery cables from battery.

2. Disconnect wires from solenoid terminals.

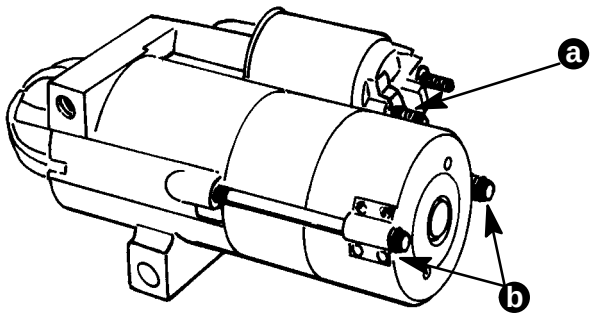
IMPORTANT: Some starter motors may use a special mounting shim for gaining flywheel clearance. Do not lose this shim; it will be needed when remounting starter on engine block.

3. Remove starter mounting bolts.

4. Pull starter assembly away from flywheel and remove from engine.

Disassembly

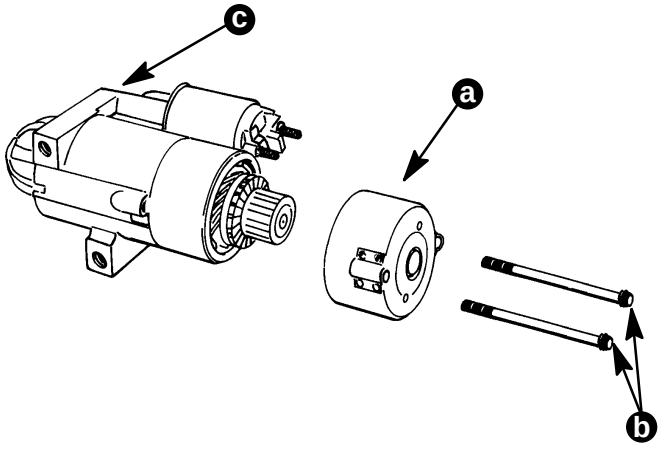
1. Remove brush lead from solenoid and screws from end frame.



74041

a - Brush Lead
b - Screws

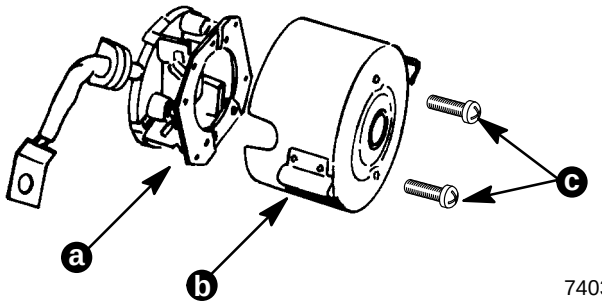
2. Remove thru bolts and separate end frame from field frame and end cap.



74040

a - End Cap
b - Thru Bolts
c - Drive Housing

3. Remove brush holder from end cap.



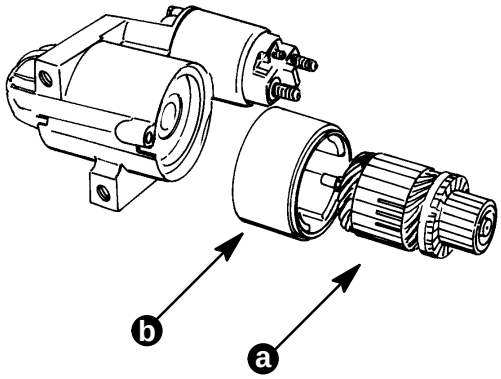
74037

a - Brush Holder
b - End Cap
c - Screws (2)

4. Remove armature and field frame from drive housing.

5. Pull armature out of field frame.

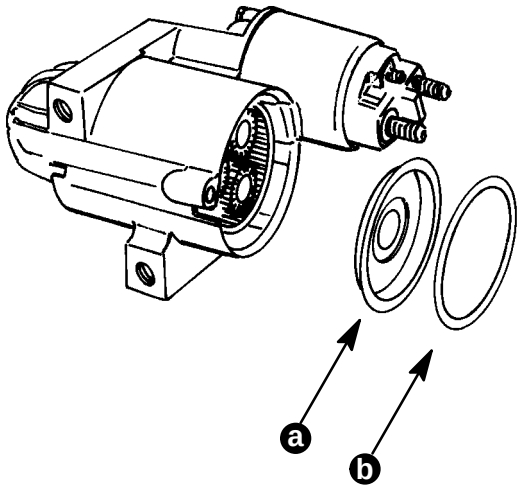
NOTE: *Permanent magnets inside field frame will be holding armature in place.*



74086

a - Armature
b - Field Frame

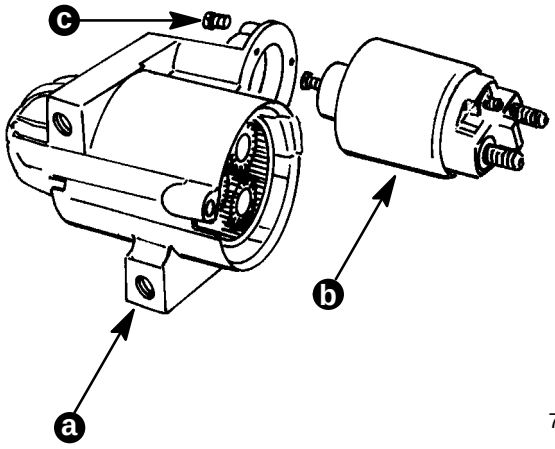
6. Remove shield and washer.



74038

a - Shield
b - Washer

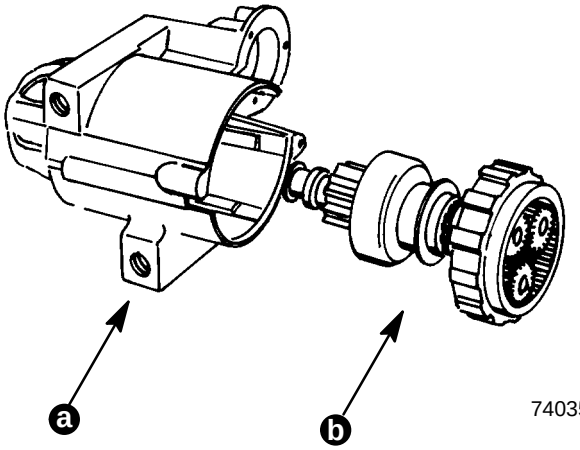
7. Remove the three screws retaining the solenoid. Remove solenoid from drive housing.



74036

a - Drive Housing
b - Solenoid
c - Screws (3)

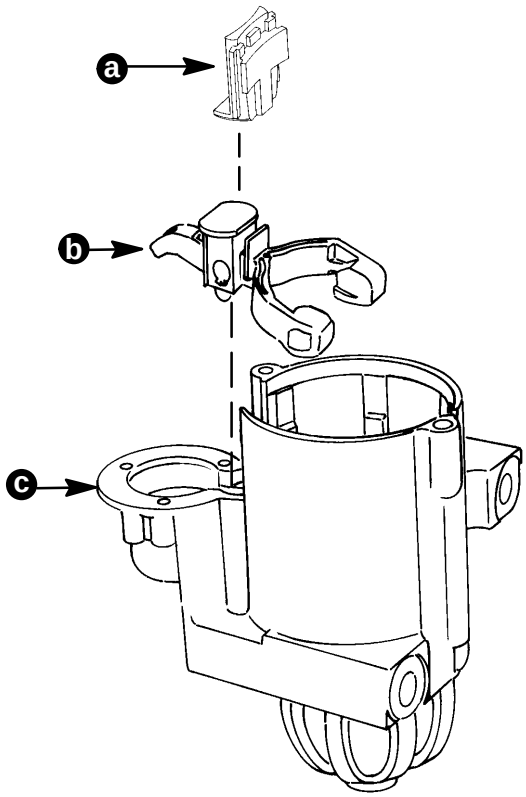
8. Remove drive and associated parts from drive housing.



74035

a - Drive Housing
b - Drive

9. Remove solenoid arm and rubber grommet from the drive housing.



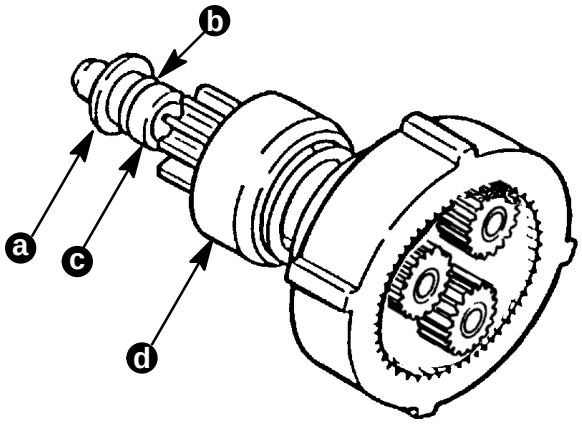
74105

74048

74018

a - Rubber Grommet
b - Solenoid
c - Drive Housing

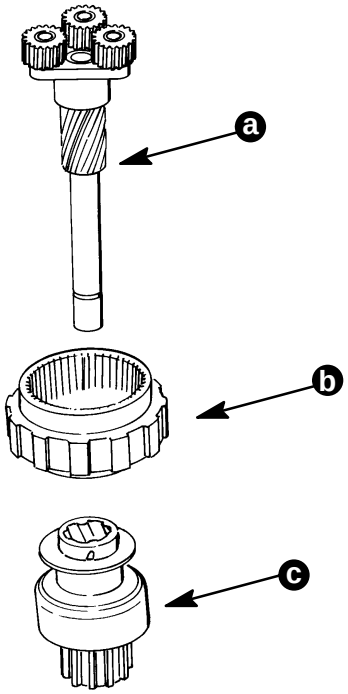
10. Remove thrust collar, retaining ring and collar from planetary shaft.



74016

a - Thrust Collar
b - Retaining Ring
c - Collar
d - Drive

11. Remove drive and gear from planetary shaft.



74087

a - Gear
b - Shaft Assembly
c - Drive

Cleaning and Inspection

IMPORTANT: Do not use grease dissolving solvents to clean electrical components, planetary gears, or drive. Solvent will damage insulation and wash the lubricant out of the drive and gears. Use clean rags and compressed air to clean components.

1. Test over-running clutch action of drive. Pinion should turn freely in over-running direction and must not slip in cranking direction. Check pinion teeth. Check spring for tension and drive collar for wear. Replace if necessary.

2. Check that brush holders are not damaged or bent and hold brushes against commutator. Check brushes for wear; refer to “Brushes and Brush Holder.”

3. Inspect armature commutator. If badly grooved or out-of-round, turn down and undercut commutator.

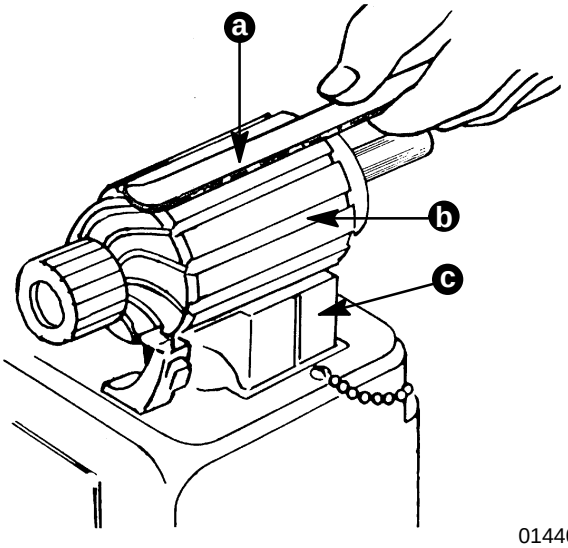
4. Inspect all roller bearing surfaces for wear. Check that bearings roll freely. If any roughness is felt, replace bearings.

5. Inspect planetary gear assembly. Gears must mesh easily and roll freely with no binding.

Armature Tests

TEST FOR SHORTS

Check armature for shorts by placing on growler and holding hack saw blade over armature core while rotating armature. If saw blade vibrates, armature is shorted. After cleaning between commutator bars, recheck. If saw blade still vibrates, replace armature.

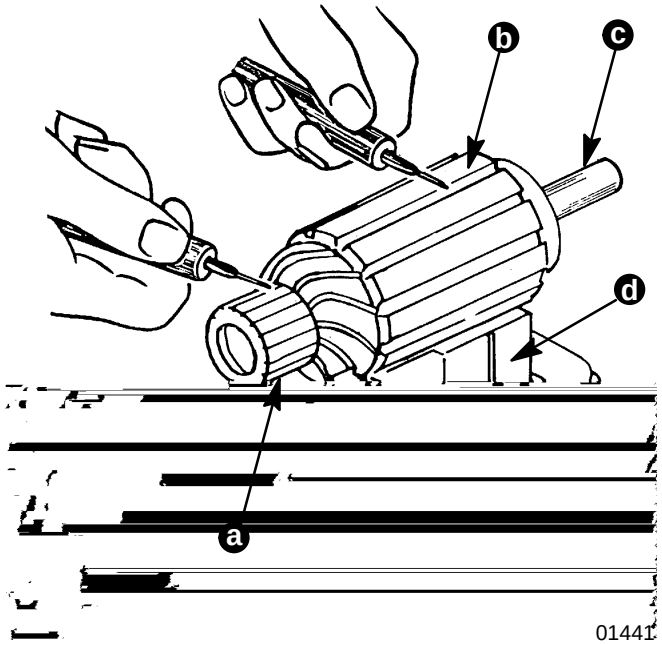


01440

a - Hacksaw Blade
b - Armature Core
c - Growler

TEST FOR GROUND

1. With continuity meter, place one lead on armature core or shaft and other lead on commutator.
2. If meter hand moves, armature is grounded and must be replaced.



01441

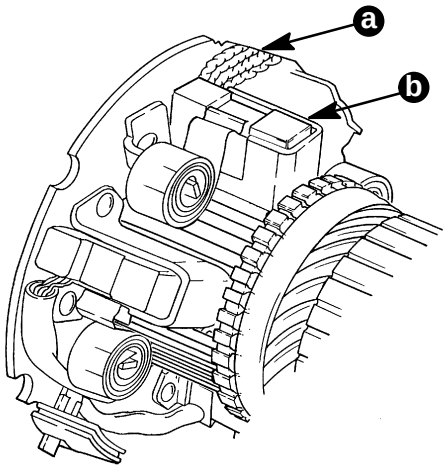
a - Commutator
b - Armature Core
c - Shaft
d - Growler

Brushes and Brush Holder

INSPECTION

Replace brushes and holder when brush leads are touching guide.

Make sure brushes move freely in guides.

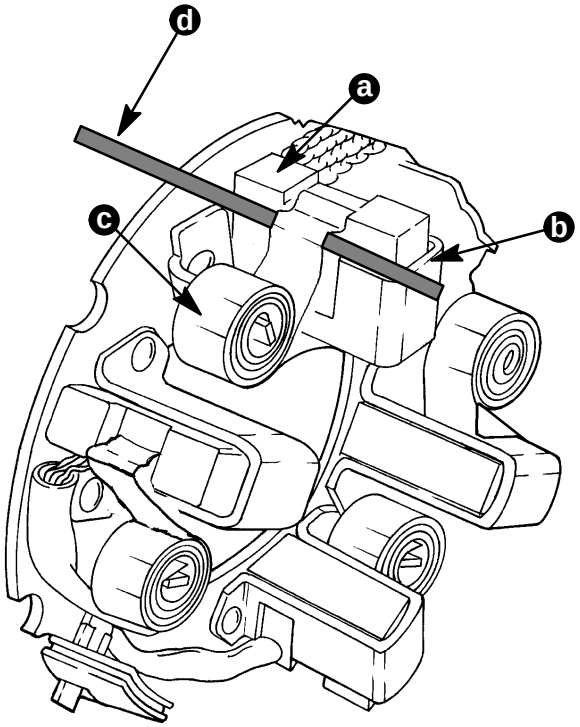


72069

a - Brush Leads
b - Guide

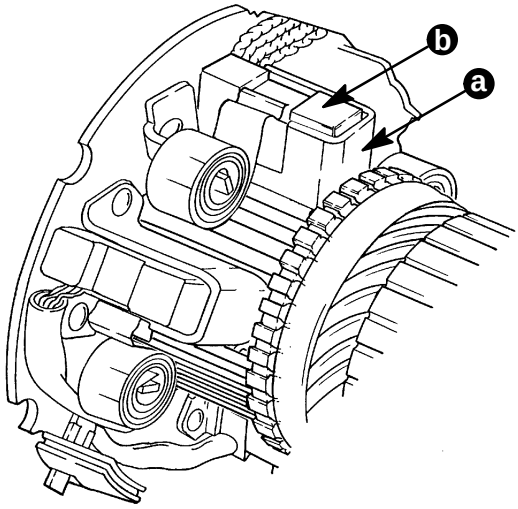
INSTALLATION

1. Push each brush up into its guide, use a 3 inch piece of coat hanger wire or similar stiff wire to retain the spring while installing armature, as shown.



a - Brush
b - Guide
c - Brush Spring
d - 3 Inch Piece Of Coat Hanger Or Stiff Wire

2. Place brush holder on armature and remove pieces of wires from brush holder.

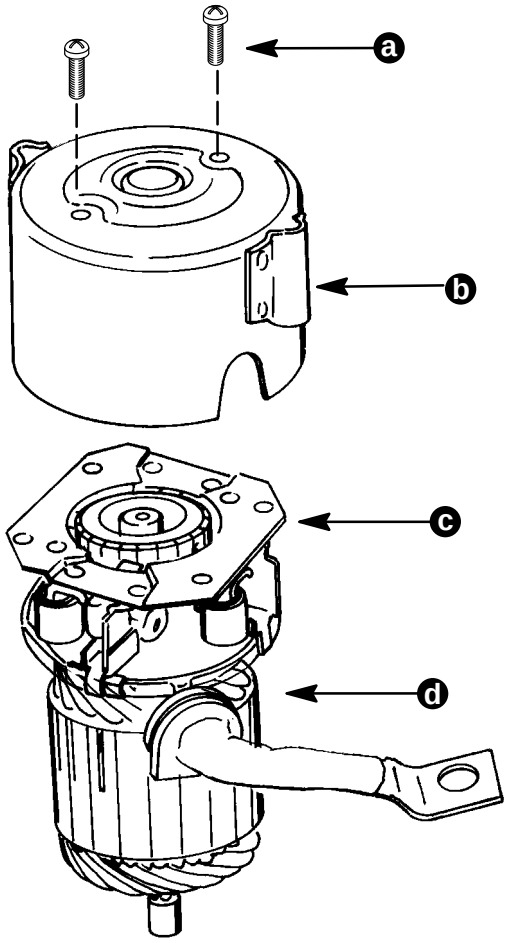


72069

a - Brush Holder
b - Brush

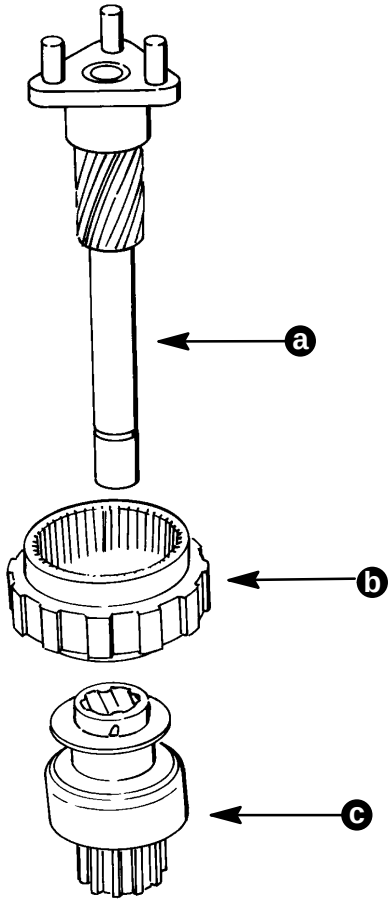
Reassembly

1. Install end frame on brush holder. Align holes of end frame with holes of brush holder. Tighten screws securely.



a - Screw (2)
b - End Cap
c - Brush Holder
d - Armature

2. Install gear and drive over planetary shaft.

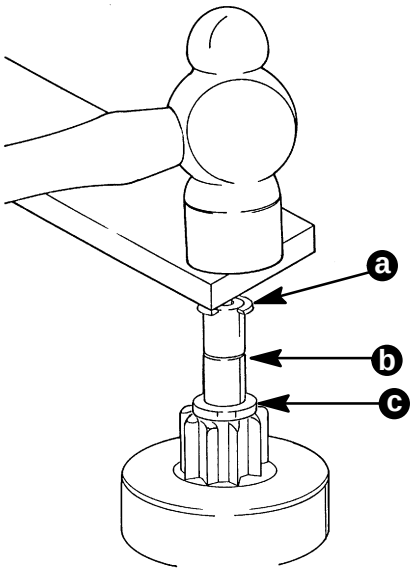


74087

a - Planetary Shaft
b - Gear
c - Drive

3. Assemble drive on shaft assembly as follows:
   a. Lubricate drive end of shaft assembly with SAE 10W oil.
   b. Place gear over shaft.
   c. Slide drive assembly onto shaft with pinion facing outward.
   d. Slide retainer onto shaft with cupped surface facing end of shaft (away from pinion).

e. Position snap ring on upper end of shaft and hold in place with block of wood. Strike wood block with hammer, thus forcing snap ring over end of shaft. Slide snap ring down into groove.

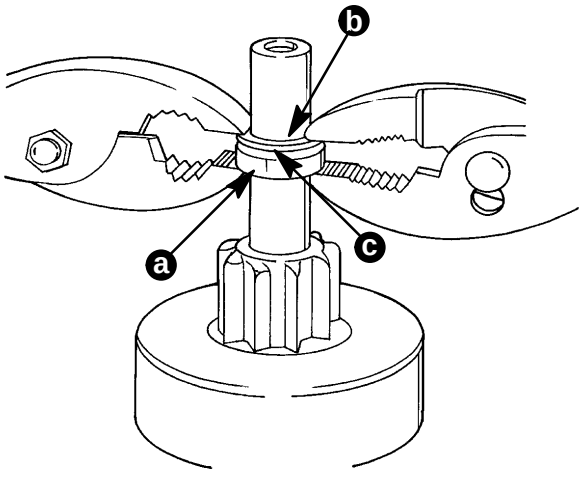


72073

a - Snap Ring
b - Groove
c - Retainer

f. Assemble thrust collar on shaft with shoulder next to snap ring.

g. Position retainer and thrust collar next to snap ring. Then, using two pliers, grip retainer and thrust collar and squeeze until snap ring is forced into retainer.

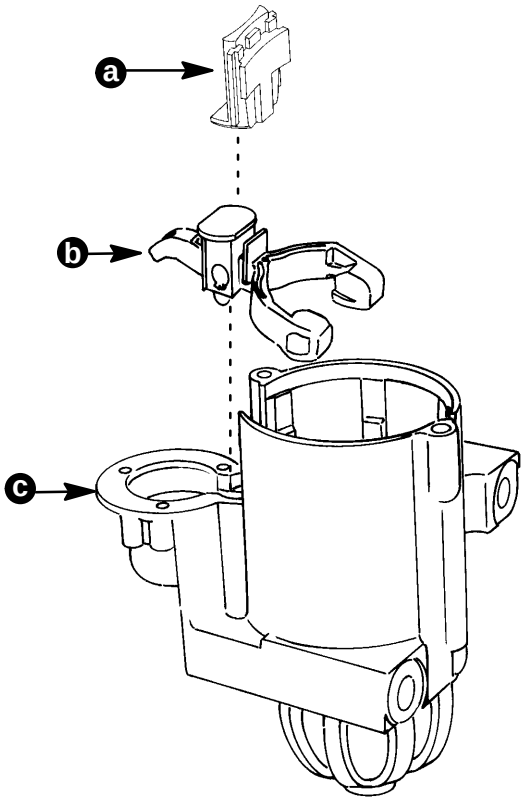


72074

a - Retainer
b - Thrust Collar
c - Snap Ring

4. Install the planetary gears on planetary shaft.

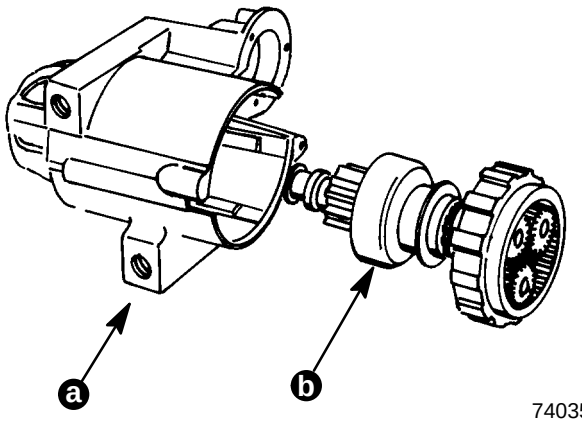
5. Install solenoid arm and rubber grommet in the drive housing.



74135

a - Rubber Grommet
b - Solenoid
c - Drive Housing

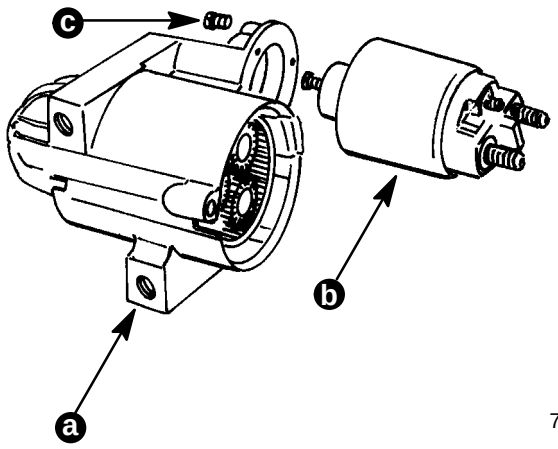
6. Install drive and associated parts in drive housing.



74035

a - Drive Housing
b - Drive

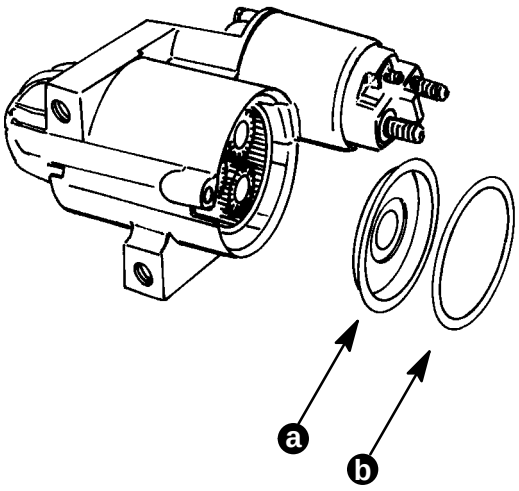
7. Place solenoid in drive housing and tighten screws.



74036

a - Drive Housing
b - Solenoid
c - Screw (3)

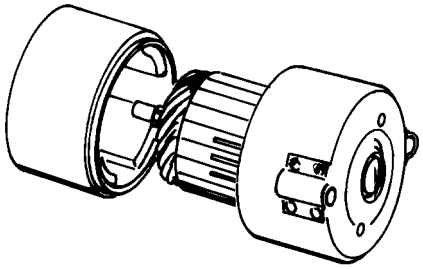
8. Install shield and washer in drive housing.



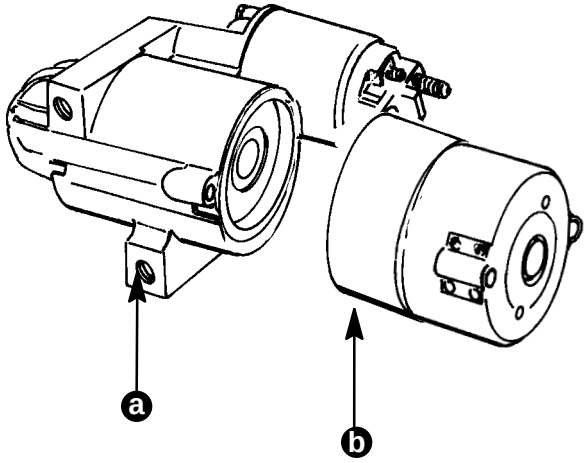
74038

a - Shield
b - Washer

9. Install field frame over armature. Align slot in end cap and field frame for proper positioning of rubber grommet.



10. Install field frame and end cap in drive housing align slots in field frame with recess in drive housing.



a - Drive Housing
b - End Cap And Field Frame

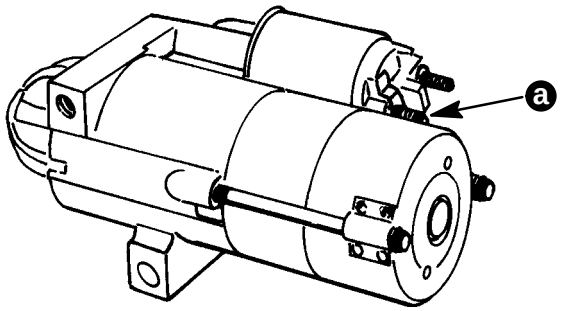
11. Install thru bolts and brush lead. Tighten fasteners securely.

Clearances

PINION CLEARANCE

Pinion clearance must be checked after reassembly of starter motor.

1. Disconnect brush lead from solenoid motor and insulate it carefully.

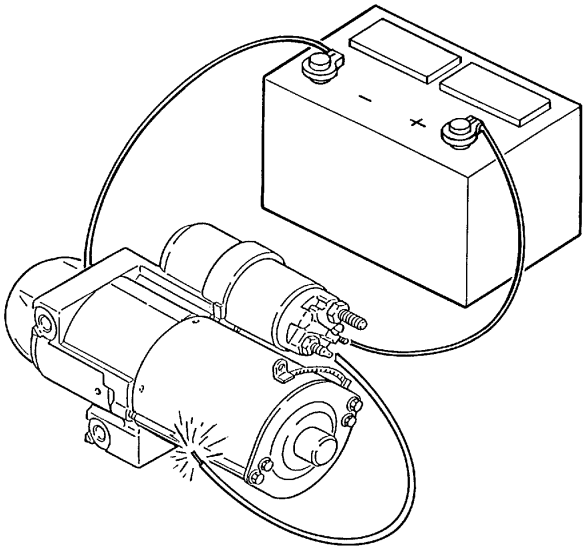


74041

a - Brush Lead

2. Connect 12 volt battery positive (+) lead to battery terminal and negative (–) lead to frame.

3. Momentarily touch a jumper lead from battery terminal to switch terminal. This shifts pinion into cranking position where it will remain until battery is disconnected.

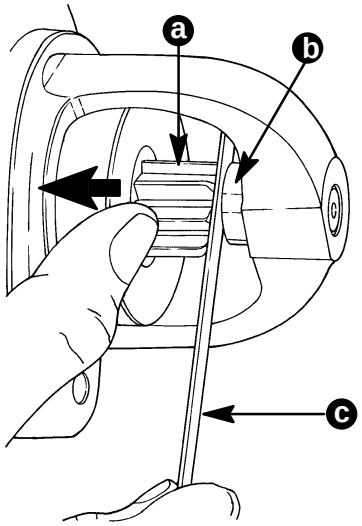


72629

4. Push pinion back toward commutator end to eliminate slack.

5. Measure distance between pinion and pinion retainer.

6. If clearance is not within limits of .010-.160 in. (0.25-4.00 mm), it may indicate excessive wear of solenoid linkage, shift lever yoke, or improper assembly of shift lever mechanism. Replace worn or defective parts, since no provision is made for adjusting pinion clearance.



72077

a - Pinion
b - Retainer
c - Feeler Gauge

Installation

IMPORTANT: Install special mounting shim (if equipped) between starter motor and engine block.

1. Place starter motor in position and install mounting bolts. Torque bolts to 30 lb. ft. (41 N·m).

2. Connect yellow/red wire to terminal S of solenoid. Connect orange wire, red wire, and battery cable to large terminal of solenoid. Tighten fasteners securely. Coat terminals with Quicksilver Liquid Neoprene. Install battery cable boot, if so equipped.

3. Connect battery cables to battery in the following order. Connect positive (+) cable to positive (+) battery terminal and tighten cable clamp. Then connect negative (–) cable to negative (–) terminal and tighten clamp.

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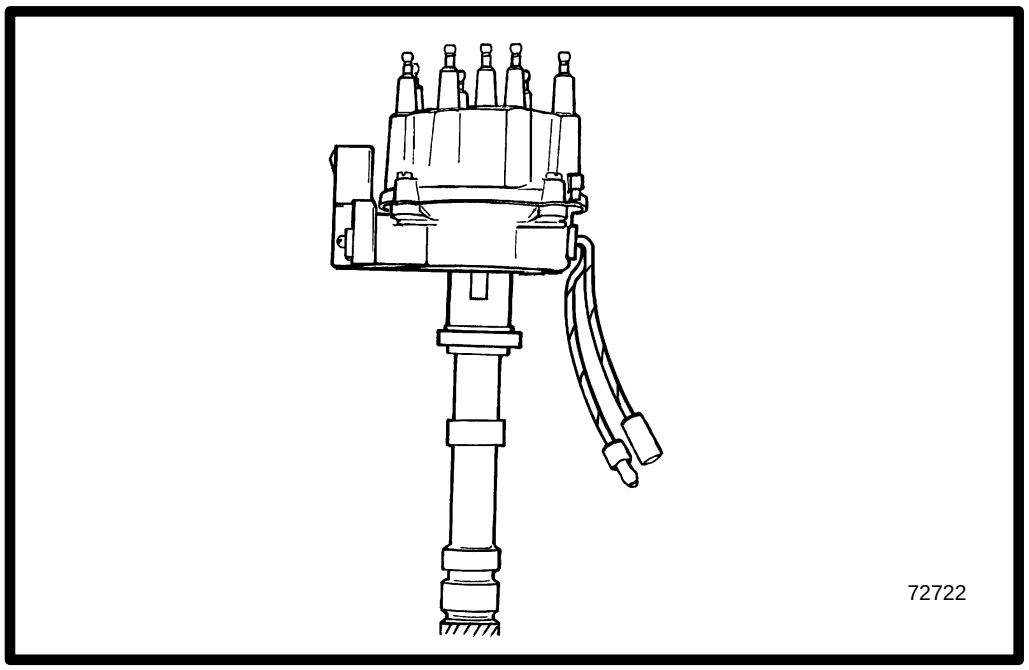
ELECTRICAL SYSTEMS

4

B



THUNDERBOLT IV AND V IGNITION SYSTEM

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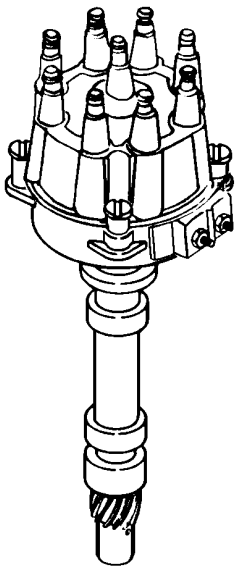
NOTICE

For information and procedures on trouble-shooting, refer to Section 1C.

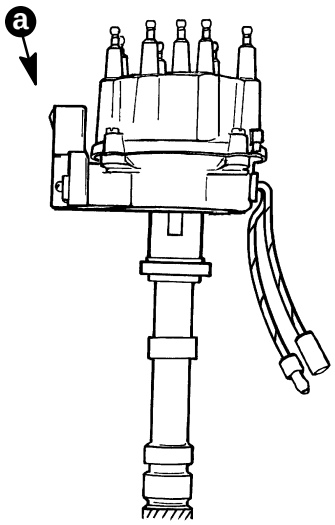
Thunderbolt IV Ignition System

Identification



71790

DISTRIBUTOR WITH IGNITION MODULE MOUNTED ON EXHAUST ELBOW



72722

DISTRIBUTOR WITH IGNITION MODULE MOUNTED ON DISTRIBUTOR BODY

a - Ignition Module

NOTE: *Except for igntion module replacement, repair procedures for both distributors are the same.*

Replacement Parts Warning

⚠ WARNING

Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

Thunderbolt IV (HEI) Electronic Ignition System

Torque Specifications

Fastener Location	In. Lb.	Ft. Lb.	N·m
Distributor Clamp		20	27
Spark Plugs (14 mm)		15	20
Ignition Module Retaining Screws (Stainless Steel)	10		1.1

Tools/Lubricants/Sealants

Description	Part Number
Timing Light	91-99379
Multi-Meter / DVA	91-99750
Torch Lamp	91-63209
Insulating Compound	92-41669--1
Quicksilver Liquid Neoprene	92-27511-2
Loctite 271	Obtain Locally
Thermalconductive Grease	

Index

Specifications

Coil

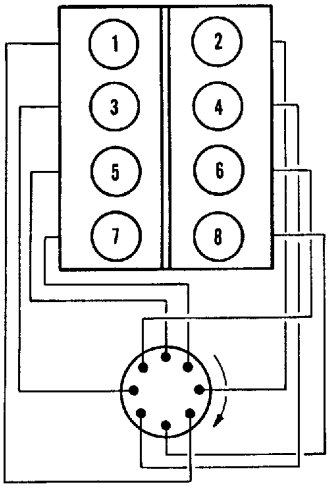
Description	Specification
Coil Part Number	392-7803A4
Primary Resistance	.60-.80 Ohms
Secondary Resistance	9,400-11,700 Ohms

Spark Plugs

Model	All MIE and MCM
Spark Plug	.040 In. (1 mm)
Spark Plug Type	AC-MR43T NGK BR6FS Champion RV15YC4

Firing Order

Firing Order 1-8-4-3-6-5-7-2



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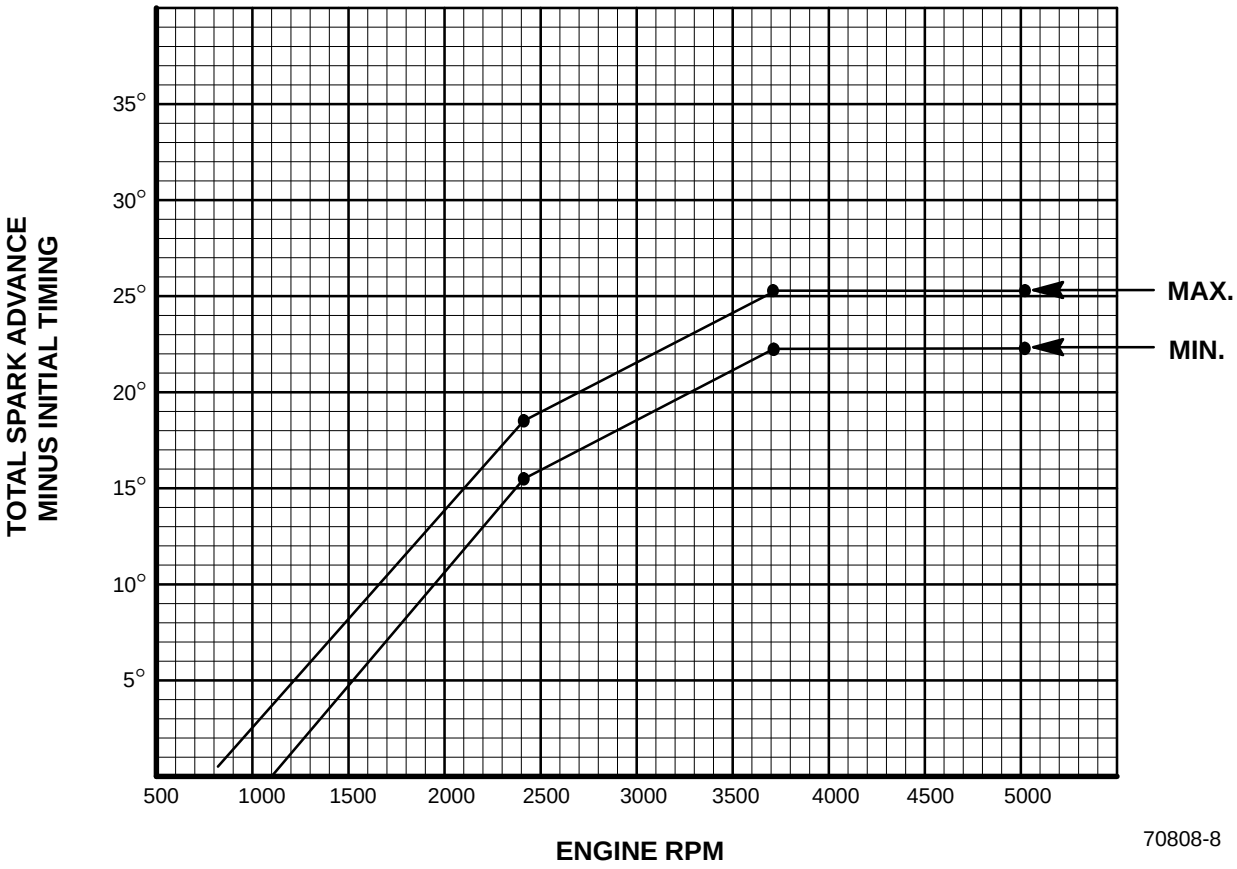
Distributor Advance Curves

IMPORTANT: Distributor advance curve charts do not include the initial engine timing. Basic initial timing must be added to chart for total advance curve. The spark advance is controlled by the ignition module.

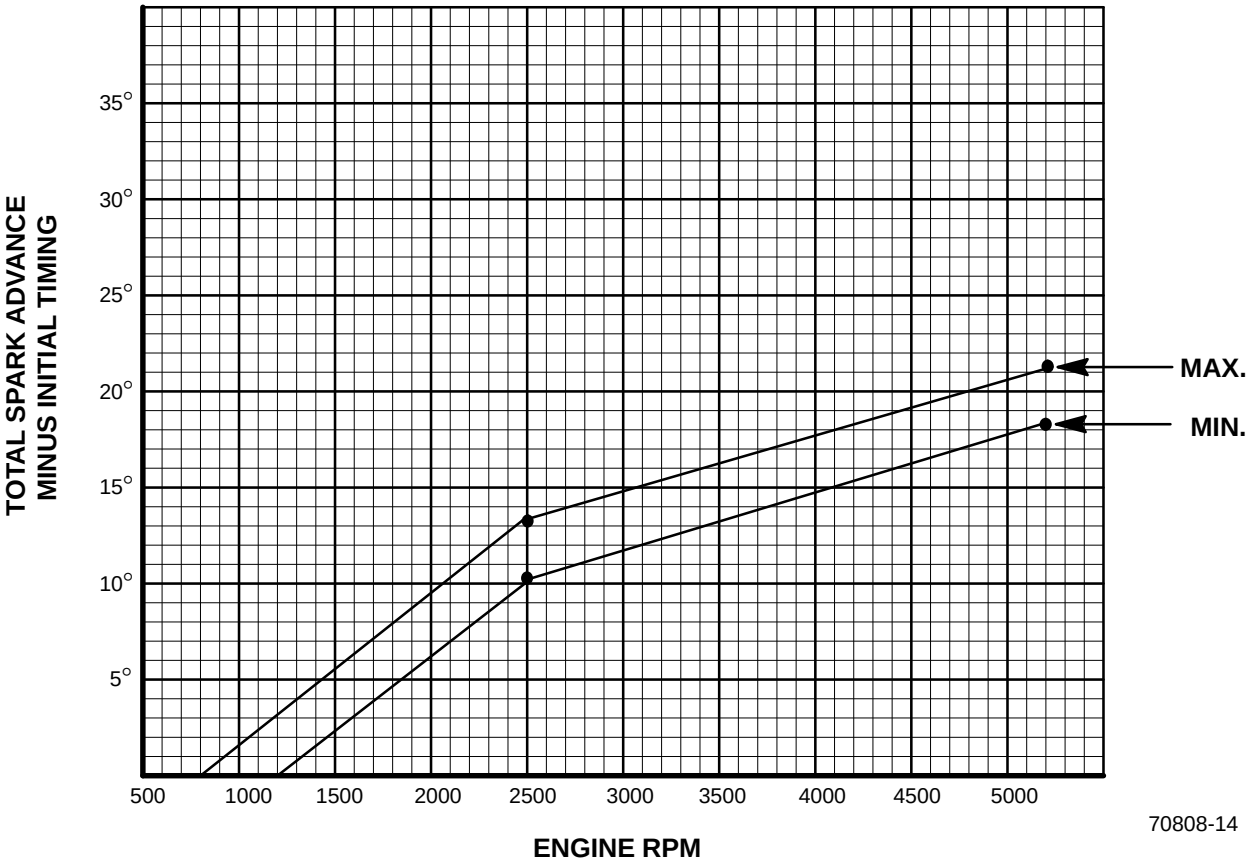
MCM 7.4L/MCM 454 MAGNUM/MIE 7.4L

Identification Mark: V8-24
Module Advance: 24 Degrees
Initial Timing: 8 Degrees BTDC
Total Advance: 32 Degrees



MCM 502 MAGNUM/MIE 8.2L

Identification Mark: V8-20R
Module Advance: 20 Degrees
Initial Timing: 8 Degrees BTDC
Total Advance: 28 Degrees



Repair

Precautions

⚠ WARNING

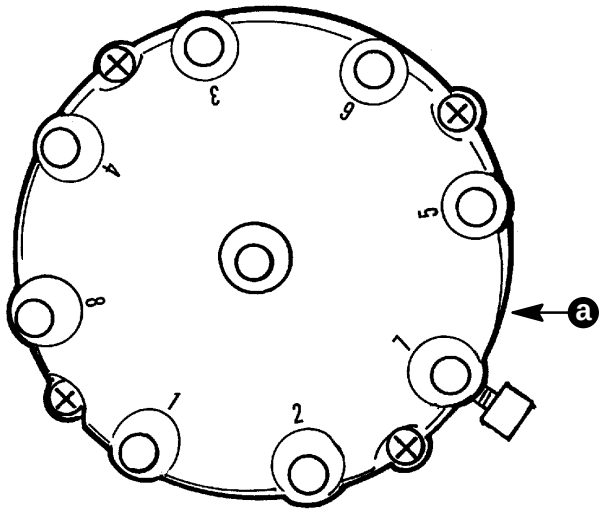
When performing the following procedure, be sure to observe the following:

- **Be sure that engine compartment is well ventilated and that no gasoline vapors are present, to avoid the possibility of fire.**
- **Be sure to keep hands, feet and clothing clear of moving parts.**
- **Do not touch or disconnect any ignition system parts while engine is running.**
- **Do not reverse battery cable connections. System is negative (–) ground.**
- **Do not disconnect battery cables while engine is running.**

Distributor Cap

1. Loosen four distributor cap retaining screws.
2. Remove distributor cap.
3. Clean cap with warm soap and water and blow off with compressed air.
4. Check cap contact for excessive burning or corrosion. Check center contact for deterioration.
5. Check cap for cracks or carbon tracks using magneto analyzer.

IMPORTANT: If high tension leads are removed from cap refer to "Spark Plug Wires" in this section and the following illustrations for installation.



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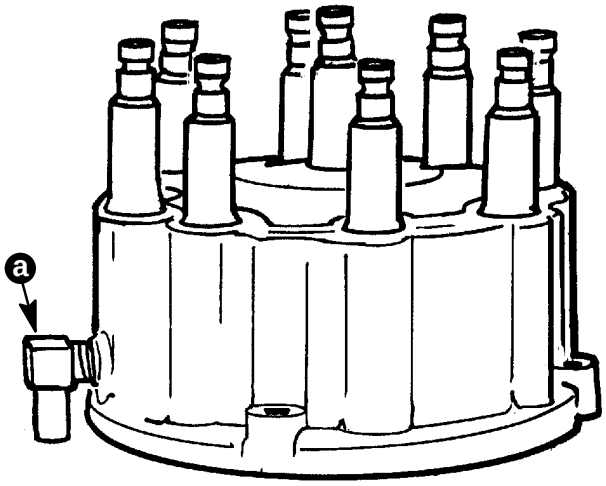
a - Alignment Notch



72728

a - Vent

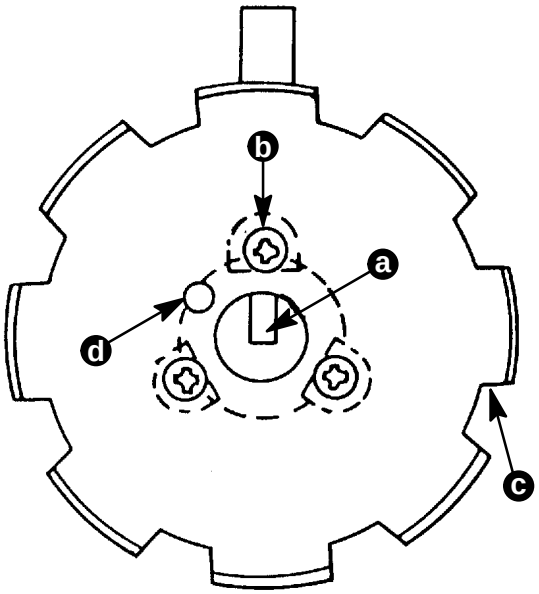
Rotor/Sensor Wheel

1. Remove distributor rotor/sensor wheel assembly from distributor shaft. Rotor and sensor wheel are secured to the shaft with Loctite. Use two flat blade screwdrivers. The screwdrivers are positioned opposite each other with the blade tips on the underside of the rotor and sensor wheel assembly. Make sure blade tips are toward distributor shaft until they come in contact with shaft. A downward push on both screwdriver handles at the same time will pry off rotor/sensor wheel assembly. The use of torch lamp will also aid in the removal of the rotor/sensor wheel assembly.

⚠WARNING

Wear protective gloves when handling heated rotor/sensor wheel assembly to avoid severe burns.

2. With the rotor/sensor wheel assembly removed, inspect the locating key inside the rotor.
3. The locating key will appear as a clean edged, 1/8 in. (3 mm) wide, sloped ramp at the bottom of the splined hole.

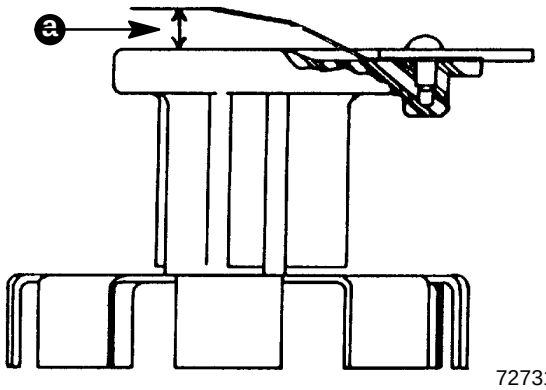


72730

a - Locating Key
b - Screws
c - Senor Wheel
d - Locating Pin

IMPORTANT: If there is any doubt if sensor wheel is located properly, lay sensor wheel on top of the figure above with sensor fingers facing up (toward you). Line up three screw holes and locating pin hole on sensor wheel with the figure. If wheel is indexed properly all the fingers on wheel will line up with those in the figure.

4. If there are pieces of material shaved off the key or if it appears to have been damaged by being forced down while misaligned with slot in distributor shaft, the rotor must be replaced.
5. Check rotor for burned or corroded center contact.
6. Check rotor for cracks and carbon tracks using magneto analyzer and instructions supplied with analyzer.
7. If rotor is damaged, replace rotor by removing three hex bolts and separating sensor wheel from rotor. Reinstall sensor wheel to new rotor making sure locating pin on rotor is installed in locating hole in sensor wheel. Tighten three hex bolts securely.
8. Bend carbon brush tang upward slightly until a distance of 1/4 in. (6 mm) is obtained between rotor and tang.



72731

a - 1/4 in. (6 mm)

9. Put 2 drops of Loctite 271 into the rotor so it lands on the locating key.
10. Put 2 drops of Loctite 271 in keyway on upper portion of distributor shaft.
11. Immediately install rotor assembly onto distributor shaft. Make sure rotor locating key is aligned with keyway in distributor shaft before pressing rotor all the way down on the shaft, until it stops, with the palm of your hand. Let Loctite cure overnight with distributor in inverted position.

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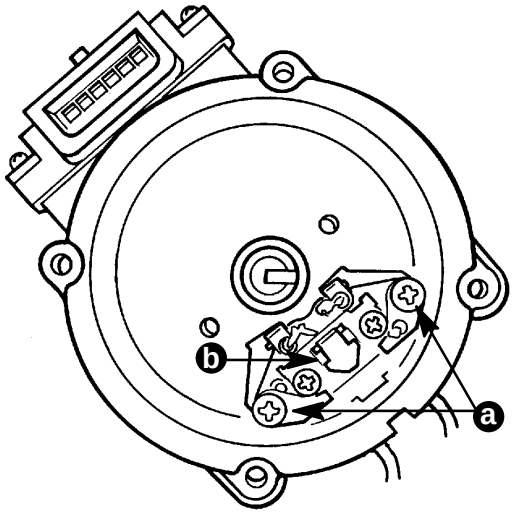
IMPORTANT: The rotor should fit very tight. It may be necessary to heat rotor with torch lamp to properly install. It is important not to let any Loctite run down distributor shaft. Loctite could get into top distributor housing bushing.

12. Reinstall distributor cap on distributor.
13. Install spark plug wires (if removed). Refer to "Spark Plug Wires" in this section.

Sensor

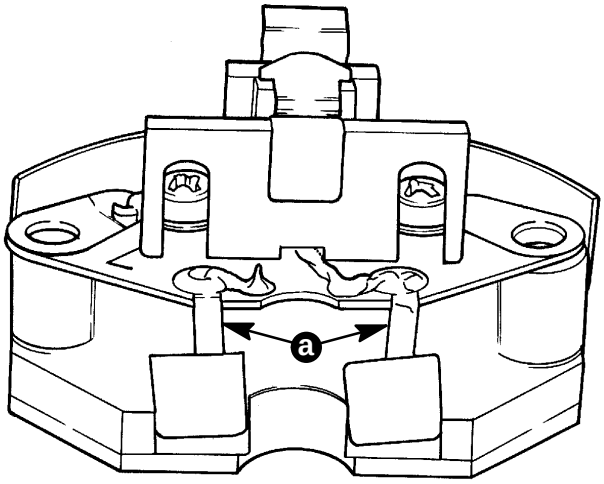
1. Remove rotor and sensor wheel.
2. Disconnect sensor wires.
3. Remove two screws that hold sensor into distributor housing. Remove sensor from housing.



72732

a - Mounting Screws
b - Senor Assembly

4. Use a magnifying glass and light to inspect the two metal "jumper leads" for cracks. If a crack is found in either metal "jumper lead," install a new sensor.



72733

a - Jumper Leads

⚠CAUTION

Do not use any type of silicone sealer on the inside of the distributor. Most silicone sealers give off an acidic vapor during the curing stage of the sealer. This acid can cause corrosion on the ignition components.

5. Install sensor into housing and install two retaining screws.
6. Install sensor wheel, rotor, and distributor cap.
7. Connect WHT/RED and WHT/GRN sensor wires (ring terminals on engine harness wires, or bullet connectors from ignition module wires). Tighten hex nuts securely, if so equipped.

Thunderbolt IV Ignition Module

IGNITION MODULE MOUNTED ON EXHAUST ELBOW

1. Unplug wiring harness connector from ignition module.
2. Remove fasteners and hardware retaining ignition module to exhaust elbow. Remove module.

NOTE: *Do not disturb spacers between ignition module plate and exhaust elbow, unless replacing spacers.*

IMPORTANT: BLACK ground (–) wire from engine harness must be placed under ignition module fastener when mounting module.

3. Replace ignition module using existing hardware. Tighten fasteners securely. Be certain BLACK ground (–) wire is in position.
4. Check that terminals of wiring harness connector are clean and free of corrosion. Plug connector into ignition module.

IGNITION MODULE MOUNTED ON DISTRIBUTOR

1. Unplug wiring harness connector from ignition module.
2. Remove stainless steel screws retaining ignition module to distributor body. Remove module.

IMPORTANT: Thermalconductive Grease must be applied to the back of the ignition module to conduct heat away from the module and to prevent corrosion.

3. Apply a thin coat of Thermalconductive Grease evenly across the metal back of the ignition module.
4. Install ignition module using the stainless steel screws. Torque screws to 10 lb. in. (1.1 N·m).
5. Check that terminals of wiring harness connector are clean and free of corrosion. Plug connector into ignition module.

Distributor Repair

Removal

1. Unplug wiring harness from ignition module on distributor housing, or disconnect wires from ignition module mounted on exhaust elbow. Disconnect sensor wires.
2. Remove distributor cap. Do not remove high tension leads unless necessary.
3. Crank engine over until timing marks line up and rotor is pointing toward No. 1 cylinder on distributor cap.
4. Mark distributor housing in reference to engine block.
5. Remove bolt and hold-down clamp and remove distributor.

IMPORTANT: To simplify distributor installation, do not turn crankshaft when distributor is removed from engine.

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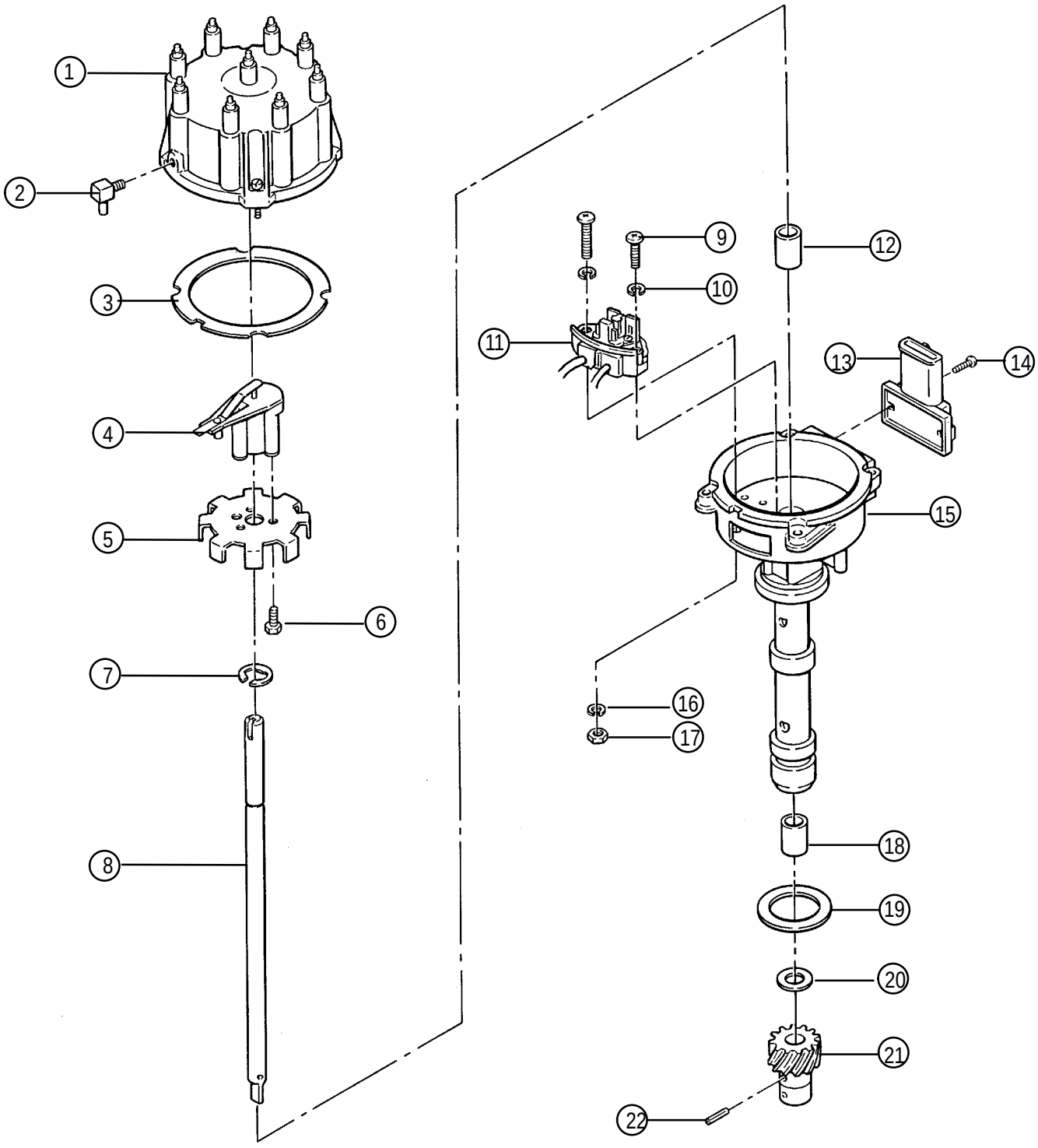
Thunderbolt IV Exploded View



1 - Distributor Cap
2 - Vent
3 - Gasket
4 - Rotor
5 - Senor Wheel
6 - Screws (5)
7 - E-Clip
8 - Shaft
9 - Screws (2)
10 - Lockwashers (2)
11 - Sensor
12 - Upper Bushing
13 - Ignition Module , If Equipped (Apply Thermal-conductive Grease)
14 - Screws (2)
15 - Distributor Housing
16 - Lockwasher
17 - Nut
18 - Lower Bushing
19 - Gasket
20 - Washer
21 - Gear
22 - Roll Pin

Disassembly

NOTICE

Refer to exploded view preceding for parts identification during disassembly and reassembly.

1. Remove rotor, sensor wheel, sensor, and ignition module (if mounted on distributor), as previously outlined.
2. Remove roll pin, washer and driven gear from distributor shaft.
3. Check for side play between shaft and distributor housing bushings. Maximum side play is .002 in. (0.05 mm).
4. Remove shaft from housing and check shaft for being bent with a dial indicator and V-blocks. Maximum runout is .002 in. (0.5 mm).

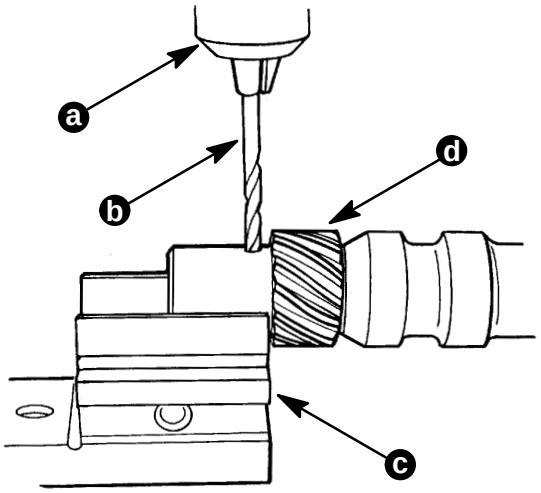
Reassembly

1. Lubricate shaft with engine oil. Install E-clip (if removed) on shaft in housing.
2. Install washer on shaft. Install original gear; slide onto shaft and install roll pin.

IMPORTANT: Hole may be offset and gear will only fit in one direction.

3. If installing a new gear, the gear will come drilled on one side. Slide gear onto shaft; align hole in gear with hole in shaft. Using these holes as guides, drill through other side of gear with a 3/16 in. carbide tripped drill.

IMPORTANT: If a new gear has only a dimple, you will have to drill through one side of the gear before you slide gear onto shaft. In most cases it is recommended to have a machine shop complete the drilling operation for new gear installation.



72735

a - Drill Press
b - 3/16 in. Carbide Tip Drill
c - V-Block
d - New Gear

4. Install sensor, sensor wheel, rotor, and ignition module (if mounted on distributor), as previously outlined.
5. Install distributor as outlined in “Distributor Installation.”

Distributor Installation

Engine Not Disturbed

1. Install new gasket on distributor housing.
2. Turn rotor approximately 1/8-turn in a counterclockwise direction past mark previously scratched on distributor housing.
3. Work distributor down into position in engine block with distributor positioned as noted during removal.

IMPORTANT: It may be necessary to move rotor slightly to start gear into mesh with camshaft gear, but rotor should line up with the mark when distributor is down in place. Distributor shaft must enter oil pump shaft for complete installation.

4. Replace and tighten distributor hold-down bolt and clamp. Connect distributor ground (–) leads.
5. Install cap. Refer to "Spark Plug Wires" and install wires.
6. Plug wiring harness into ignition module on distributor housing, on distributors so equipped. Connect wires from ignition module to distributor terminals, on all models.
7. Coat any exposed terminals with Quicksilver Liquid Neoprene.
8. Time ignition as outlined under "Ignition Timing."

Engine Disturbed

1. Locate No. 1 piston in firing position by following instructions "a" or "b":
   a. Remove No. 1 spark plug and, with finger on plug hole, crank engine until compression is felt in No. 1 cylinder. Continue cranking until pointer lines up with timing mark on crankshaft pulley.
   b. Remove rocker cover and crank engine until No. 1 intake valve closes, continuing to crank slowly until pointer lines up with timing mark on crankshaft pulley.
2. Position distributor to opening in block in normal installed attitude.

IMPORTANT: Make sure oil pump shaft is engaged in the following. Position (align) oil pump shaft end to engage bottom of distributor dive gear prior to inserting distributor if necessary.

3. Position rotor to point toward No. 1 cylinder on cap (with distributor housing held in installed attitude), then turn rotor counterclockwise approximately 1/8-turn more and work distributor down to engage camshaft and oil pump shaft. It may be necessary to rotate rotor slightly until engagement is felt.

⚠CAUTION

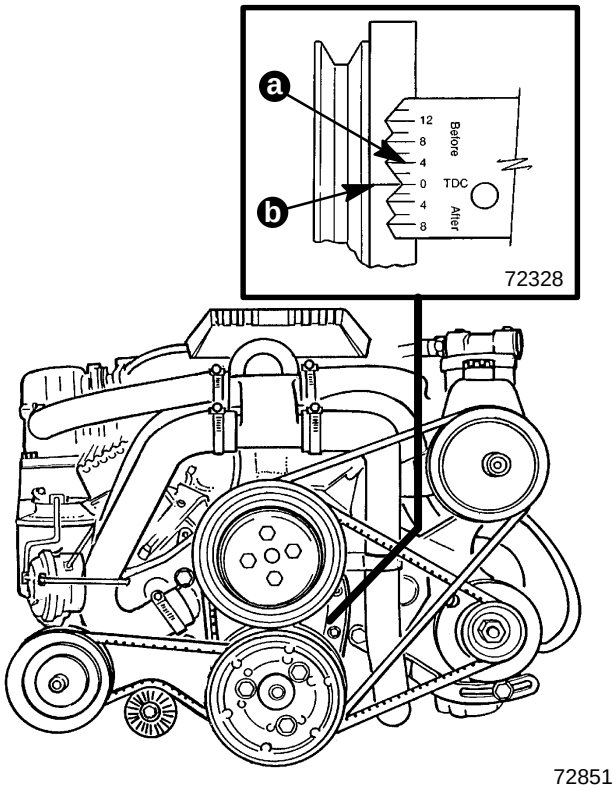
Avoid severe engine damage. Do not attempt to force distributor into position using hold-down clamp and bolt.

4. When distributor housing contacts intake manifold, camshaft and oil pump shaft are engaged. Install hold-down clamp and bolt and snug up bolt.
5. Connect distributor ground (–) leads, if so equipped.
6. Place distributor cap in position and check that rotor lines up with terminal for No. 1 spark plug. Install new gasket on distributor housing. Install cap.
7. Refer to "Spark Plug Wires" and install wires. Refer to "Specifications" for firing order.
8. Plug wiring harness into ignition module on distributor housing, on distributors so equipped. Connect wires from ignition module to distributor terminals, on all models.
9. Coat any exposed terminals with Quicksilver Liquid Neoprene.
10. Time ignition as outlined under "Ignition Timing."

Thunderbolt IV Ignition Timing

1. Connect timing light (91-99379 or similar) to No. 1 spark plug. Connect power supply leads on light to 12 volt battery. Refer to “Specifications” for cylinder numbering and location.
2. Connect tachometer to engine.
3. Start engine and run at normal idle speed.
4. Aim timing light at timing tab, located on timing gear cover and crankshaft torsional damper.

IMPORTANT: GM engine timing marks (on tab) are in 2-degree increments. MCM and MIE LH engines will have “A” (Advance) mark to the left of “0.” Timing must be set on the “A” side of “0” (Top Dead Center).



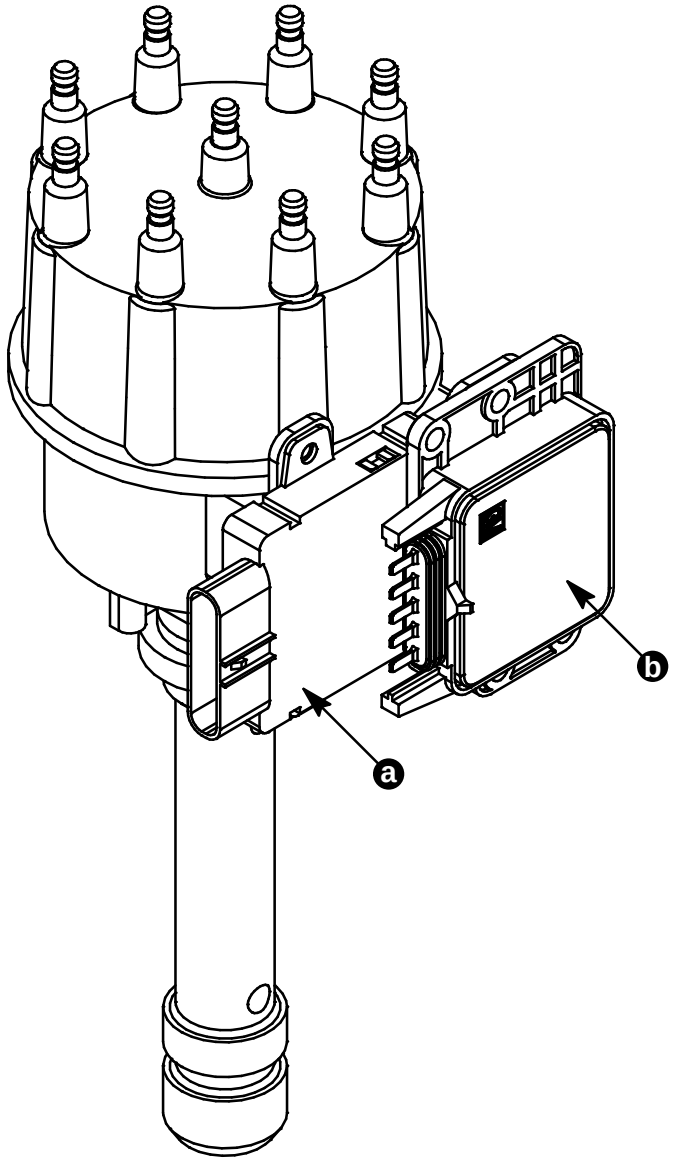
a - Degree Marks
b - Timing Mark

5. Adjust timing by loosening distributor clamp and rotating distributor body as required until timing mark on damper or pulley lines up with the mark on tab specified in “Specifications.” Tighten clamp and recheck location of timing mark.
6. Stop engine and remove timing light.

Thunderbolt V Ignition System

Identification

The Thunderbolt V ignition system uses the same distributor as the Thunderbolt IV system. The Ignition Control Module and Knock Control Module are mounted with the ignition control module.



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a - Ignition Control Module
b - Knock Control Module

General Description

The Thunderbolt V ignition system has several spark control features that will be described following:

- Idle Speed Spark Control
- Acceleration Spark Advance
- Mean-Best-Timing Spark Advance
- Over-Speed Control (Rev-Limiter)
- Knock Retard Spark Control

NOTE: *The Ski models do not have the Mean Best Timing feature.*

Idle Speed Spark Control

The ignition module will control ignition timing to maintain a calibrated idle speed. This is accomplished by making small spark advance adjustments. This feature is only active within a certain RPM range. This range may be slightly different from one engine model to another. The approximate range is 400-700 RPM.

Acceleration Spark Advance

This feature is active during acceleration only. When accelerating, the ignition module may add more spark advance to the “Base Spark Timing Curve”. The amount of spark advance added, is totally dependant on how fast RPM increases (how fast the throttle is moved). This feature is also active within a certain RPM range. This range may be slightly different from one engine model to another. The approximate RPM range for this feature is 1200-4000 RPM. Within this range, the module can add approximately 10 degrees of spark advance to the base spark timing curve.

Mean-Best-Timing (MBT) Spark Advance

During light load cruising, the ignition module searches for the optimal ignition timing. This is also accomplished by small changes to the spark advance. At a given RPM, the module will try to add a small amount of advance and wait to see if there is an RPM change. If RPM increases, it will try to increase timing more. The module will continue to advance timing until it no longer gets an increase in RPM. Conversely, if it senses an RPM drop, it will start to retard some of the spark timing. The approximate RPM range for this feature is 1200-4000 RPM. Within this range, the ignition module can add approximately 10-15 degrees of spark advance to the base spark timing curve.

NOTE: *The Audio Warning System is also connected into the ignition module circuit. If the audio warning system becomes activated by the closing of one of the audio warning system switches, the MBT feature is deactivated.*

Over-Speed Control

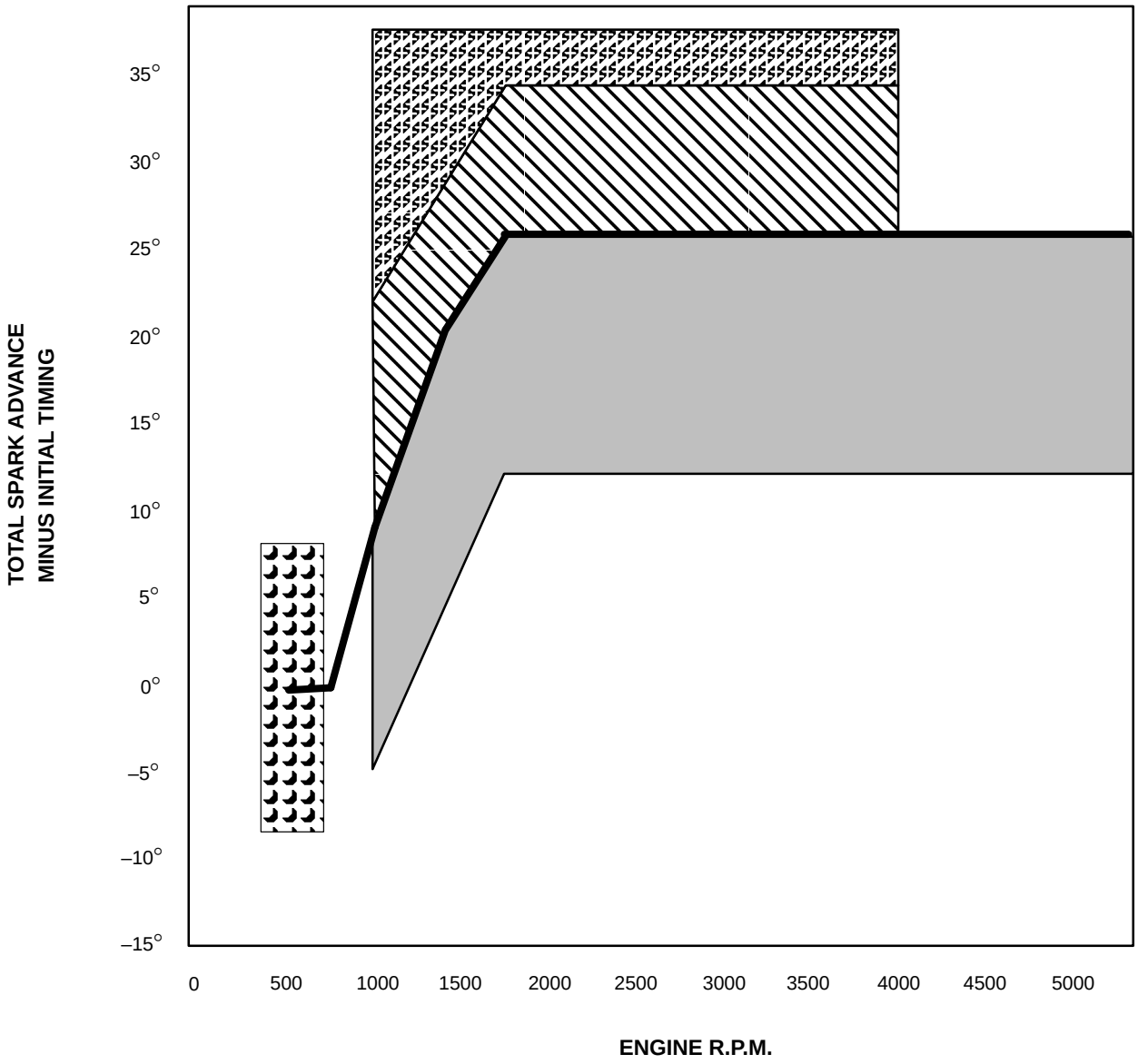
The ignition module will prevent the engine speed from exceeding a preset limit by stopping the spark. This feature has an RPM range that varies from model to model. The over-speed limit for a particular engine is set slightly higher than the top end of the RPM range for that model. For example, if the recommended range is 4600-5000 RPM, the over-speed limit would be set at 5100 RPM. When RPM reaches this limit, spark is turned-off until engine RPM drops down to a “Reset RPM”, which would be approximately 4750 RPM for this example. At this point, spark comes back on.

Knock Retard Spark Control

The knock control feature helps provide protection from harmful detonation. Knock control is handled by the Knock Control Module. This module receives a signal from a sensor that is mounted on the engine block. The knock control module works in conjunction with the ignition module to retard the timing if spark knock is present.

Thunderbolt V Spark Control Graph

IMPORTANT: The graph below shows the typical advance ranges for a Thunderbolt V ignition control module. The numbers plotted on the graph are not representative of any particular model. It is only presented to provide an understanding of how the system functions.



= Base Timing Advance Curve

= Idle Speed Advance Range

= Knock Retard Range

= Acceleration Advance Range

= MBT Advance Range

Circuit Description

Refer to the circuit wiring diagram on the following page for reference to this circuit description.

Ignition Control Module

- The ignition module receives its power (+) thru the PURPLE wire “9”.
- Ignition module ground (–) is accomplished thru the BLACK wire “10”.
- There is also a Case Ground (–) wire “12” that is connected to one of the ignition module attaching screws.
- The 12 volt signal from the ignition module to the distributor is carried thru the WHITE/RED wire “8”, to the distributor sensor and back to the ignition module thru the WHITE/GREEN wire “7”.
- The tachometer signal is carried to the instrument panel thru the GRAY wire “11”.
- The PURPLE/WHITE wire “3” carries the signal from the knock control module to the ignition control module.
- There are two BLACK wires “5” that have bullet connectors. This circuit is reserved for future options. On current models, the two BLACK wires must be connected for the system to function properly.
- The TAN/BLU wire “6” carries a signal from the Audio Warning circuit to the ignition module.

Knock Control Module

- The knock control module receives it’s power (+) from the PURPLE wire “4”.
- Knock module ground (–) is accomplished thru the BLACK wire “2”.
- The PURPLE/WHITE wire “3” carries the signal from the knock control module to the ignition control module.
- The BLUE wire “1” carries the signal from the knock sensor to the knock module.

Ignition Control System Timing Lead

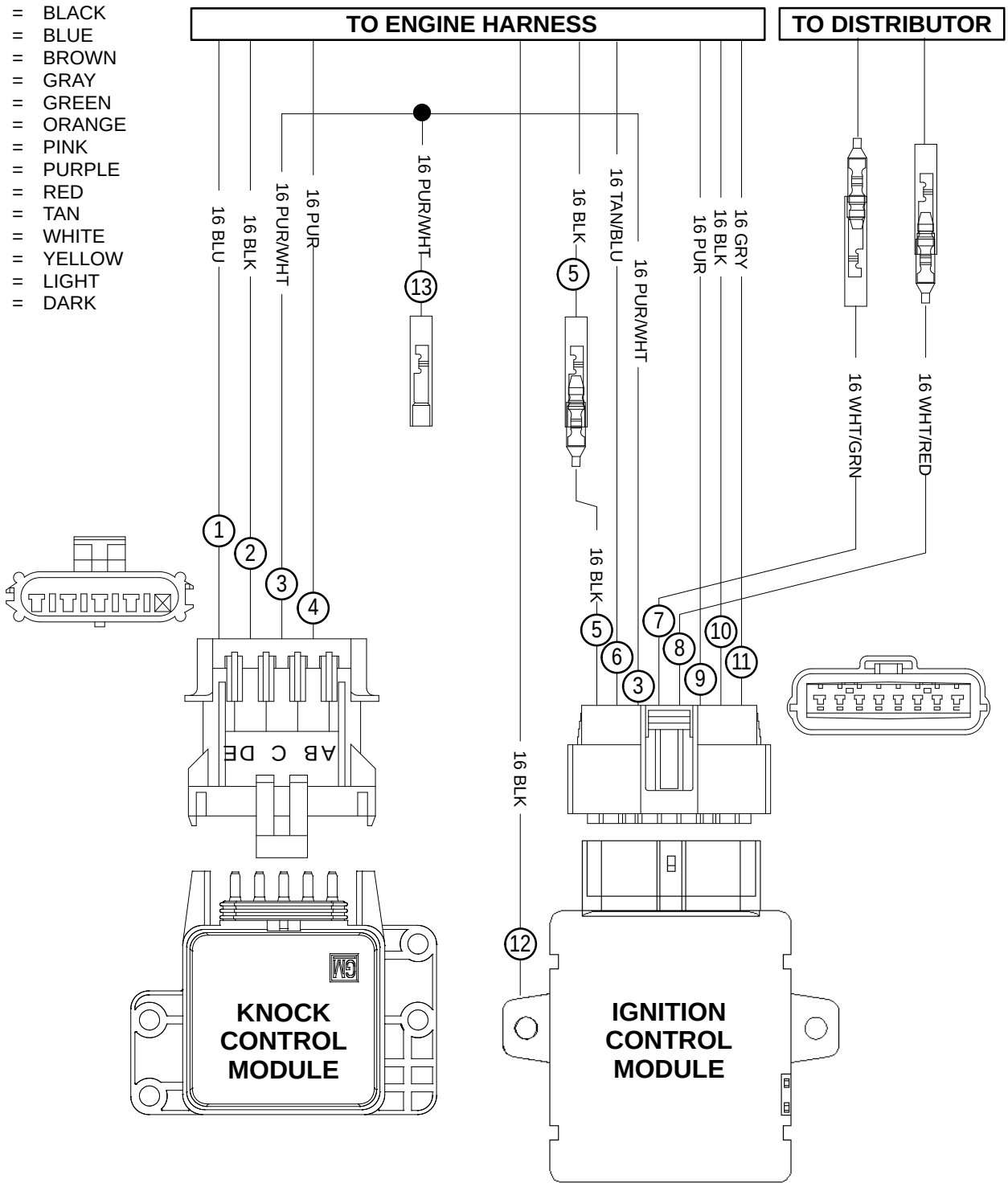
The ignition control system has a lead with bullet connector “11” that is connected into the PURPLE/WHITE wire “3”. This lead is used for performing the following tests and procedures:

- Setting “Base Ignition Timing”
- Setting “Engine Idle Speed”
- Setting “Idle Mixture”
- Testing Knock Control Circuit

This lead, when connected to an engine ground (–), locks the ignition control module into the “Base Timing” mode.

Ignition System Wiring Diagram

BLK = BLACK
BLU = BLUE
BRN = BROWN
GRY = GRAY
GRN = GREEN
ORN = ORANGE
PNK = PINK
PUR = PURPLE
RED = RED
TAN = TAN
WHT = WHITE
YEL = YELLOW
LIT = LIGHT
DRK = DARK



1 - Knock Sensor Wire
2 - Ground Wire (–) For Knock Module
3 - Knock Module Signal Wire
4 - Battery (+) Positive Wire To Knock Module
5 - Ground (–) For Furture Options
6 - Audio Warning System Wire
7 - Distributor Wire
8 - Distributor Wire
9 - Battery (+) Positive Wire To Ignition Module
10- Ground Wire For Ignition Module
11- Tachometer Wire
12- Ignition Module Case Ground (–)
13- Timing Lead (For Setting Timing and Other Tests)

Timing and Idle Adjustment Procedures For Thunderbolt V Ignition

Setting Base Ignition Timing

1. Connect timing light to number 1 spark plug. Connect timing light power supply leads (if applicable) to 12 volt source.
2. Connect a shop tachometer to engine.
3. Using a jumper wire, connect the ignition system timing lead “13” (PUR/WHT wire) to a good engine ground (–). This locks the ignition module into the “Base Timing Mode”.
4. Start engine and run at normal idle speed. Allow engine to reach normal operating temperature.
5. Aim timing light at timing tab, located on the timing gear cover and crankshaft torsional damper.
6. Adjust timing using the conventional method.

IMPORTANT: Be sure to disconnect the jumper wire from the ignition system test terminal before attempting to resume normal operations. If the jumper wire is left in place, the ignition module will operate in the “Base Timing Mode”. This means that the additional timing advance features would not function.

7. Make sure that the distributor has been tightened. Remove the jumper wire from the timing terminal.
8. Stop engine and remove timing light.

Adjusting Idle Mixture

The procedure for adjusting carburetor idle mixture can be found in the appropriate engine service manual. This procedure also requires that the ignition module be locked in the “Base Timing Mode”.

IMPORTANT: In order to properly set idle mixture, the ignition module MUST BE locked in the “Base Timing Mode”. This is necessary because of the “Idle Speed Control” feature that exists in the ignition module. See information on the previous pages about this feature.

1. Using a jumper wire, connect the ignition system timing lead “13” (PUR/WHT wire) to a good engine ground (–). This locks the ignition module into the “Base Timing Mode”.
2. Adjust idle mixture following the procedure in the appropriate engine service manual.
3. Remove the jumper wire from the timing terminal.

Adjusting Engine Idle Speed

This procedure should be done with boat in the water, drive unit in neutral and engine at normal operating temperature. Refer to the Operation and Maintenance Manual for the correct idle speed.

1. Disconnect the throttle cable from carburetor.

IMPORTANT: In order to properly set idle speed, the ignition module MUST BE locked in the “Base Timing Mode”. This is necessary because of the “Idle Speed Control” feature that exists in the ignition module. See information on the previous pages about this feature.

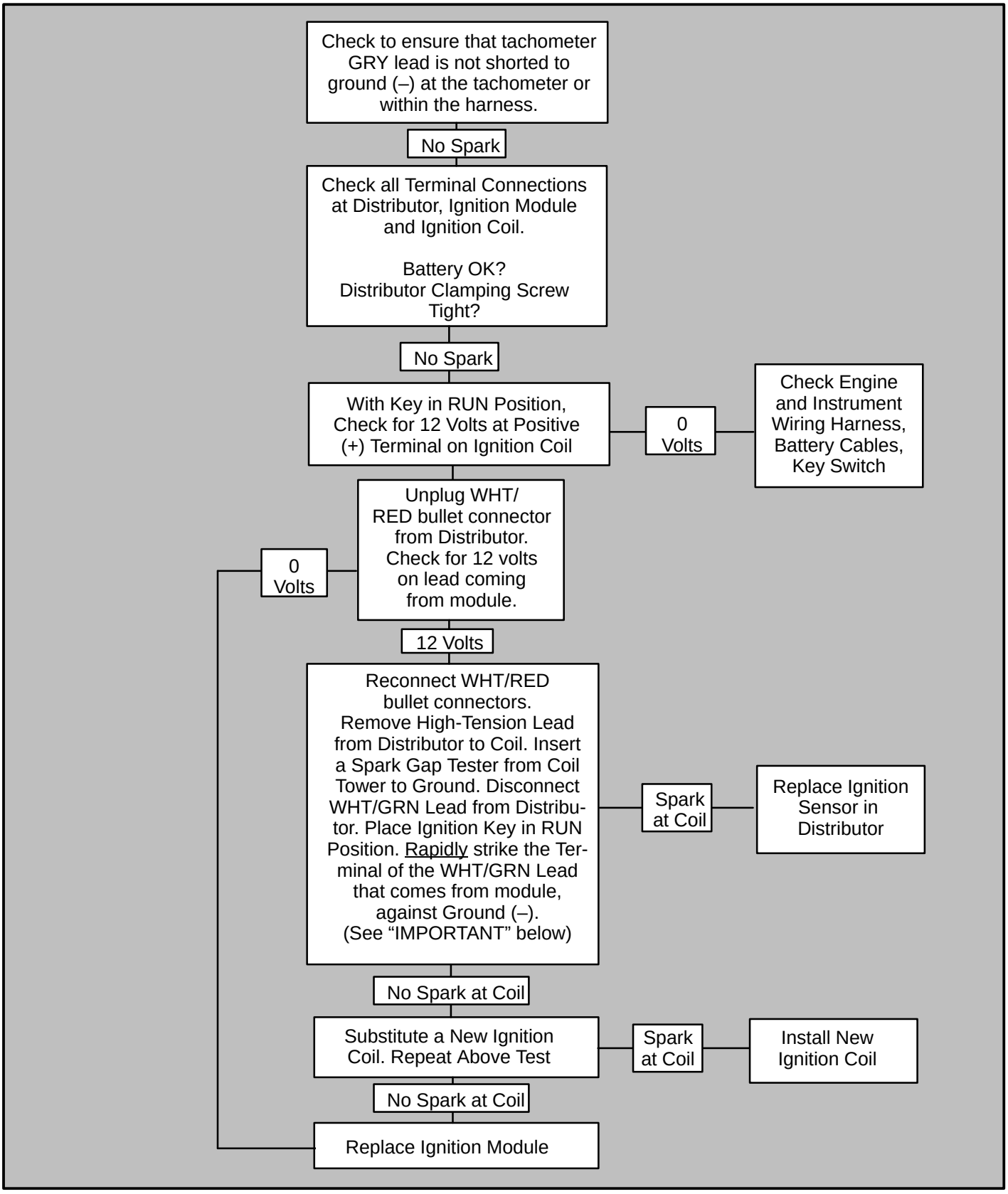
2. Connect a shop tachometer to engine.
3. Using a jumper wire, connect the ignition system timing lead “13” (PUR/WHT wire) to a good engine ground (–). This locks the ignition module into the “Base Timing Mode”.
4. Start engine and allow it to reach normal operating temperature.
5. Adjust idle speed to recommended RPM.
6. Stop engine. Readjust cable barrel and reinstall the throttle.

IMPORTANT: Be sure to disconnect the jumper wire from the ignition system test terminal before attempting to resume normal operations. If the jumper wire is left in place, the ignition module will operate in the “Base Timing Mode”. This means that the additional timing advance features would not be functioning.

7. Remove the jumper wire from the timing terminal.

Troubleshooting Thunderbolt V Ignition

Ignition Control Module / Coil / Distributor



IMPORTANT: The WHT/GRN lead must be touched against ground (–) 2-3 times per second to simulate a running engine. Repeat this test several times to ensure that spark is present.

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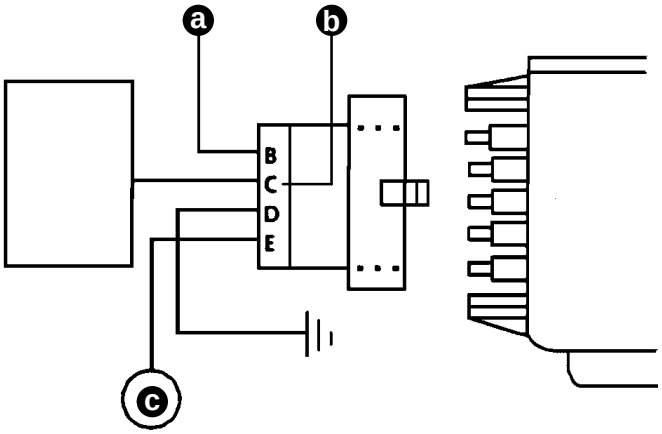
Knock Control Module

The Knock Control Module contains solid state circuitry which monitors the knock sensor's AC voltage signal and then supplies an 8-10 volt signal, if no spark knock is present, to the Ignition Control Module. If spark knock is present, the Knock module will remove the 8-10 volt signal to the Ignition Control Module.



Knock Sensor System

a - Positive Lead (12 Volts)
b - 8-10 Volts To Knock Sensor
c - Knock Sensor

It is extremely important that the correct knock module and sensor be used for the engine application. Using an incorrect knock module or sensor will result in unrecognized spark knock and engine damage. The Knock module terminal B is powered by 12 volts from the ignition switch. If the 12 volt power source is not present, the knock module cannot send an 8-10 volt signal to the ignition control module and a false constant spark retard will result.

Terminal "E" of the knock module is the signal line from the knock sensor. If this circuit opens or shorts to ground, the knock module will never remove the 8-10 volt signal from terminal "C" to and no spark retard will occur. The ground circuit for the knock module is connected to terminal "D". If the ground circuit opens, the knock module will not be able to remove the 8-10 volt signal and spark knock cannot be controlled.

IMPORTANT: If knock sensor wire is routed too close to secondary ignition wires, the Knock module may see the interference as a knock signal, resulting in false timing retard.

IMPORTANT: If there is abnormal mechanical engine noise (rattles or knocks), they may give a false knock retard signal. If fuel octane is too high or too low, a false signal can also be sent.

TESTING KNOCK MODULE AND SENSOR

NOTE: *A digital volt-ohmmeter (DVOM) and an unpowered test light (low power test light - 300mA or less) are needed to conduct the following test.*

⚠WARNING

Avoid fire or explosion. Ensure that engine compartment is well ventilated and gasoline vapors are not present when performing electrical tests inside the engine compartment. Sparks generated by electrical tests could ignite gasoline vapors causing fire or explosion.

1. Start engine and warm it up to normal operating temperature.
2. Connect the positive (+) lead from the DVOM to the PURPLE/WHITE timing terminal that comes from the engine harness (see previous wiring diagram). Connect the negative (–) lead from the DVOM to a good engine ground (–). With the engine running, there should be 8-10 volts on this circuit. If voltage is not present, check to ensure that there is 12 volts to the knock module (PURPLE wire Terminal "B").
3. Advance the throttle to approximately 1500 RPM.
4. Disconnect the harness connector (BLUE wire) from the knock sensor. Connect the unpowered test light to a positive (+) 12 volt source. To simulate an AC voltage, rapidly tap the knock sensor harness terminal with the test light. If knock module and wiring is functioning properly, you should see a voltage drop on the DVOM. If a voltage drop is not seen, check the BLUE wire from the sensor to the knock module for a short or open circuit. If the circuit is functioning properly to this point, the knock sensor may not be functioning. Proceed to the following step.
5. Reconnect the knock sensor harness connector to the sensor.
6. While still watching the DVOM, lightly and rapidly tap on the engine block near the knock sensor with a small hammer. If the knock sensor is functioning properly, you should see the voltage decrease. If a voltage drop is not seen, the knock sensor is faulty.

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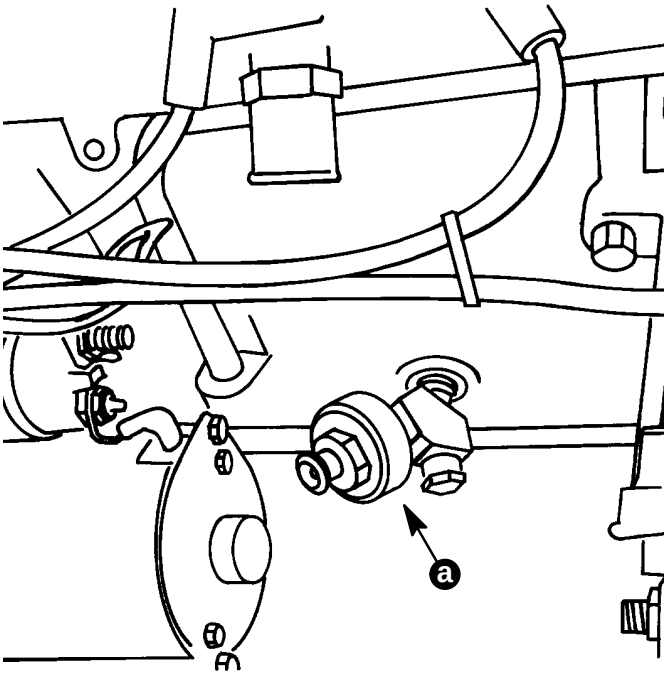
INSTALLATION OF KNOCK SENSOR

IMPORTANT: If installing a new knock sensor, be sure to replace it with an identical part. Knock sensors are very sensitive and designed for each specific application.

IMPORTANT: It is very important that the knock sensor be torqued to the exact specification. Incorrect torquing will result in unsatisfactory performance. DO NOT use sealer on threads.

1. Install knock sensor in engine block. Torque to 12-16 lb. ft. (16.3-21.7 N·m).



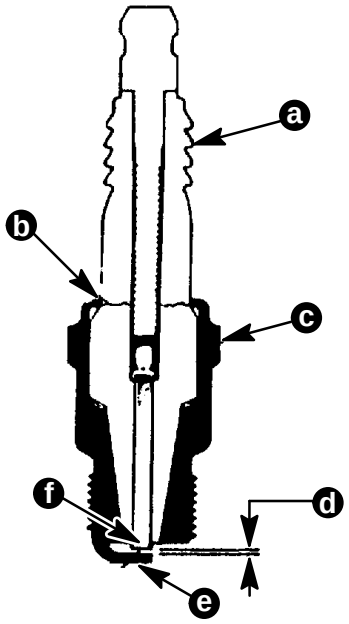
73756

a - Knock Sensor

2. Connect electrical connector to knock sensor.

Spark Plugs

1. Inspect each plug individually for badly worn electrodes, glazed, broken or blistered porcelain and replace where necessary.
2. Inspect each spark plug for make and heat range. All plugs must be the same make and number and heat range. Refer to “Specifications” for spark plug numbers.
3. Adjust spark plug gaps with a round feeler gauge. Refer to “Specifications” for proper spark plug gap.



72734

a - Porcelain Insulator
b - Insulator Cracks Often At This Point
c - Shell
d - Proper Gap
e - Side Electrode (Bend To Adjust Gap)
f - Center Electrode (File When Adjusting Gap - DO NOT Bend)

4. Clean spark plug seating area. Do not use gaskets on taper seat plugs. Install spark plugs and torque to specifications. Where used, gasket must be fully compressed to complete heat transfer and provide a gas- tight seal in cylinder. For this reason, as well as the necessity of maintaining correct plug gap, correct torque is very important during installation.

IMPORTANT: Tapered seat spark plugs are not interchangeable with non-tapered (with gasket) spark plugs.

Spark Plug Wires

1. Inspect spark plugs for damage.
2. Check spark plugs for continuity using Multi-Meter / DVA (91-99750) or similar.
3. Replace any wiers that are cracked, cut, or have damaged spark plug boots.
4. Replace any wires that do not show continuity from end to end.
5. Reinstall wires in proper order. Observe the following:

IMPORTANT: Proper positioning in spark plug wire supports is important to prevent cross-firing.

IMPORTANT: Before installing coil wire to coil, apply approximately 1/2 oz. of insulating compound around top of coil lead tower. Force nipple into coil and wipe off excess. Make sure boot does not "hydraulically back off" the distributor cap terminal.

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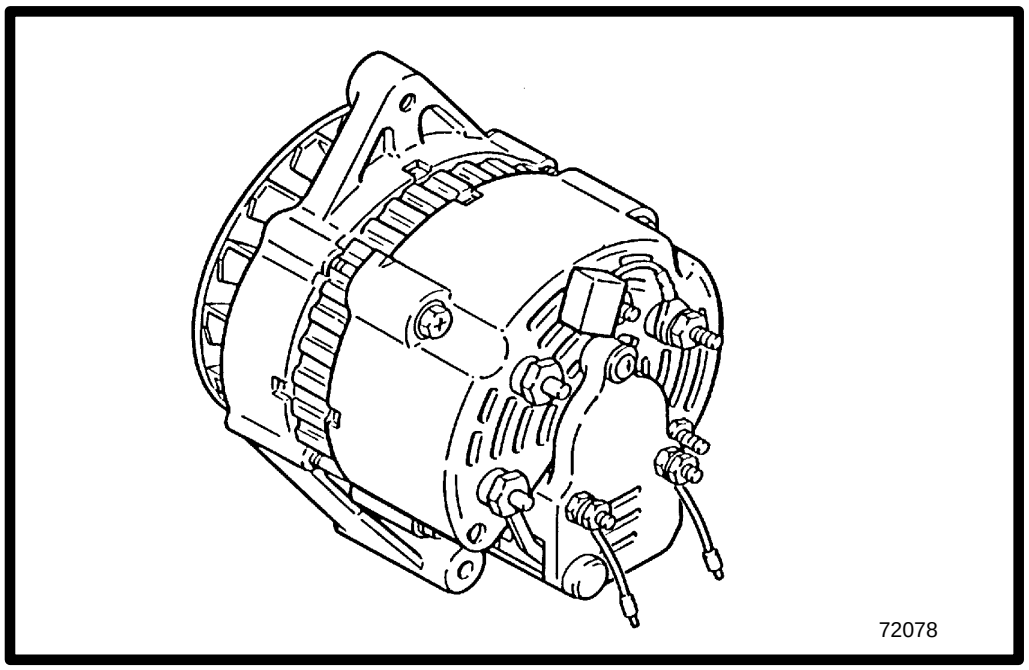
ELECTRICAL SYSTEM

4

C



CHARGING SYSTEM

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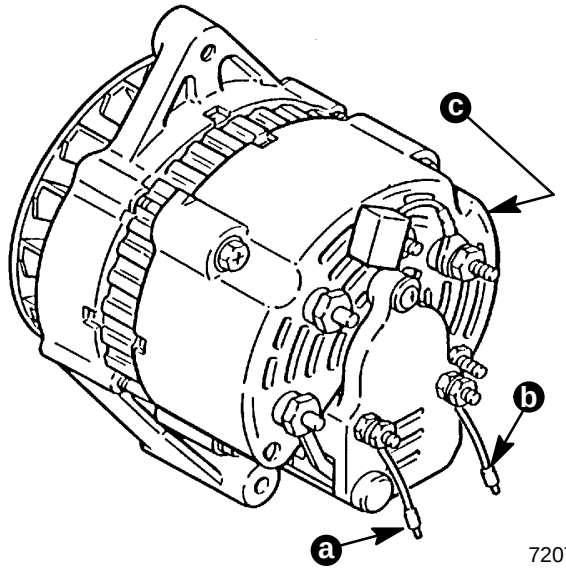
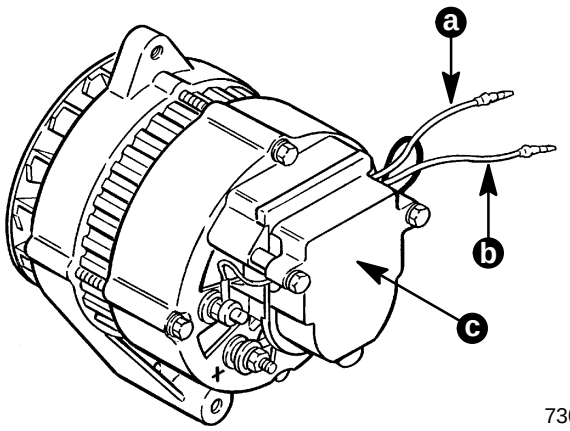
Identification



72078

Mando 55 and 65 Amp Alternator

a - Excitation Wire - PURPLE
b - Sensing Wire - RED/PURPLE
c - Mando Part Number (Hidden In This View)



73078

Prestolite 65 Amp Alternator

d - Excitation Wire - PURPLE
e - Sensing Wire - RED/PURPLE
f - Prestolite Part Number (Hidden In This View)

Replacement Parts Warning

⚠ WARNING

Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

Mando 55 and 65 Amp Alternator

Specifications

Description	Specification
Excitation Circuit	1.3 to 2.5 Volts
Current Output 55 Amp.	50 Amp. Min.
65 Amp.	60 Amp. Min.
Voltage Output	13.9 to 14.7 Volts
Min. Brush Length	1/4 in. (6 mm)

Tools/Sealants

Description	Part Number
Bearing Removal and Installation Kit	91-31229A5
Magneto Analyzer	91-76032
Universal Puller Plate	91-37241
Multi-Meter/DVA Tester	91-99750
Quicksilver Liquid Neoprene	92-27511-2
Ammeter (0-50 mm)	Obtain Locally

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Torque Specifications

Fastener Location	in. lb.	ft. lb.	N·m
End Frame Screws	55		5.5
Brush Setscrews	18		1.5
Regulator Mounting Screws	42		4.2
Regualtor Leads	25		2.5
Ground Terminal Nut	25		2.5
Pulley Nut	42		4.2
Alternator Brace to Alternator		20	27
Alternator Brace to Block		30	41
Alternator to Mounting Bracket		35	48
Alternator Mounting Bracket		30	41
V-Belt Tension (Note)	Depress 1/4 in.		

Description

The alternator has a rotor, which is supported in two end frames by ball bearings, and is driven by a pulley at approximately twice engine speed. The rotor contains a field winding that is enclosed between two multiple-finger pole pieces. The ends of the field winding are connected to two brushes (mounted in the rear end frame) which make continuous sliding (or slipping) contact with the slip rings. The current (flowing through the field winding) creates a magnetic field that causes the adjacent fingers of the pole pieces to become alternate north and south magnetic poles.

A 3-phase stator is mounted directly over the rotor pole pieces and between two end frames. It consists of three windings wound 120 degrees electrically out-of-phase on the inside of a laminated core. The windings are all connected together on one end, while the other ends are connected to a full-wave rectifier bridge.

The rectifier bridge contains six diodes which are arranged so that current flows from ground, through the stator and to the output terminal, but not in the opposite direction.

When current is supplied to the rotor field winding, and the rotor is turned, the movement of the magnetic fields created induces an alternating current into the stator windings. The rectifier bridge then changes this alternating current to direct current which appears at the output terminal. A diode trio also is connected to the stator windings to supply current to the regulator and the rotor field during operation.

Voltage output of the alternator is controlled by regulating the current supplied to the rotor field. This is accomplished by a transistorized voltage regulator that senses the voltage at the battery and regulates the field current to maintain alternator voltage within prescribed limits for properly charging the battery. Current output of the alternator does not require regulation, as maximum current output is self-limited by the design of the alternator. As long as the voltage is regulated within the prescribed limits, the alternator cannot produce excessive current. A cut-out relay in the voltage regulator also is not required, as the rectifier diodes (which allow current to flow in one direction only) prevent the battery from discharging back through the stator.

Due to the lack of residual magnetism in the rotor pole pieces, a small amount of current must be supplied to the rotor field to initially start the alternator charging. This is accomplished by means of an excitation circuit in the regulator which is connected to the ignition switch. Once the alternator begins to produce output, field current is supplied solely by the diode trio, as explained, preceding.

The alternator also is equipped with a fan (mounted on the rotor shaft) which induces air flow through the alternator to remove the heat created by the rectifiers and stator. A capacitor protects the rectifier system from high voltages and suppresses radio noise.

Precautions

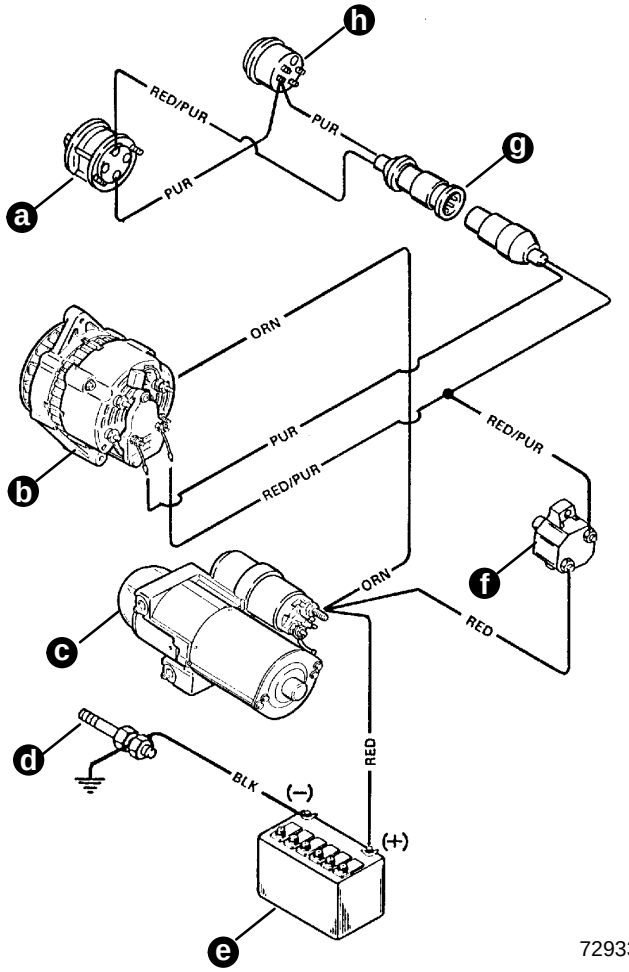
The following precautions MUST BE observed when working on the alternator system. Failure to observe these precautions may result in serious damage to the alternator or alternator system.

1. DO NOT attempt to polarize the alternator.
2. DO NOT short across or ground any of the terminals on the alternator, except as specifically instructed in the “Troubleshooting Tests.”
3. NEVER disconnect the alternator output lead or battery cables when the alternator is being driven by the engine.

4. NEVER disconnect regulator lead from alternator regulator terminal when the alternator is being driven by the engine.
5. ALWAYS remove negative (–) battery cable from battery before working on alternator system.
6. When installing battery, BE SURE to connect the positive (+) battery cable to the positive (+) battery terminal and the negative (–) (grounded) battery cable to negative (–) battery terminal.
7. If a charger or booster battery is to be used, BE SURE to connect it in parallel with existing battery (positive to positive; negative to negative).

System Components

The alternator system consists of the alternator, battery, the ignition switch and the wiring which connects these components.



a - Ignition Switch
b - Alternator
c - Starter Motor
d - Ground Stud
e - Battery
f - Circuit Breaker
g - Harness Plug
h - Battery Meter

Periodic Maintenance

The following maintenance check should be performed every 50 hours or 60 days (whichever comes first) in fresh water areas or every 25 hours or 30 days in salt water areas.

⚠CAUTION

Remove all battery cables from battery (before conducting the following check) to prevent accidentally shorting out electrical system.

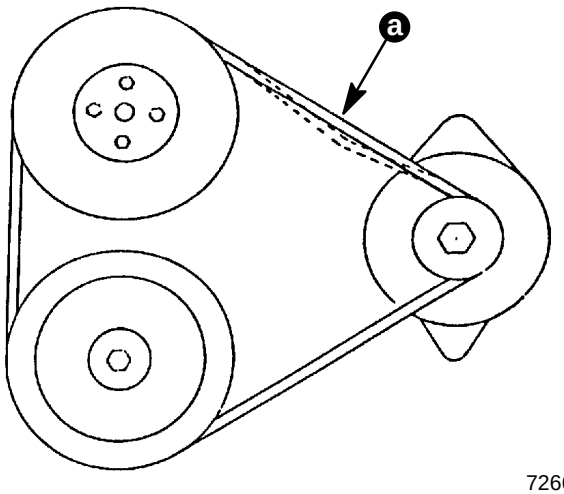
1. Inspect entire alternator system for corroded or loose connectors.
2. Check wiring for frayed or worn insulation.
3. Check alternator drive belt for excessive wear, cracks, fraying and glazed surfaces. Also, check drive belt tension and adjust, if necessary, as explained under “Drive Belt Tension Adjustment.”
4. Check alternator mounting bolts for adequate tightness.
5. Inspect slip ring end frame flame arrestor screen for debris and clean, if necessary, using compressed air or a cloth. Screen MUST BE clean, or alternator may overheat.

Drive Belt Tension Adjustment

Alternator

1. Install drive belt on pulleys and adjust tension as follows:

   a. Pivot alternator away from engine, as required, until correct tension is obtained as shown. Belt should depress 1/4 in. (6 mm).



72669

a - Check Point

   b. After obtaining correct tension, securely retighten alternator brace attaching bolts and alternator mounting bolts.

2. If a new drive belt has been installed, recheck belt tension after running for five minutes.

Troubleshooting Tests (Alternator on Engine)

Use the following tests in conjunction with the “Troubleshooting” in Section 1. Before proceeding with the tests, however, perform the following checks to eliminate possible problem areas. Also observe “Precautions,” preceding, to prevent damage to alternator system.

1. If problem is an undercharged battery, check to ensure that undercharged condition has not been caused by excessive accessory current draw or by accessories which have accidentally been left on. Also, check that undercharged condition has not been caused by running engine at too low a speed for extended periods of time.
2. Check physical condition and state of charge of battery, as outlined in “Battery - Storage” in Section 4A. Battery MUST BE at least 75% (1.230 specific gravity) of fully charged to obtain valid results in the following tests. If not, charge battery before testing system.
3. Inspect entire alternator system wiring for defects. Check all connections for tightness and cleanliness, particularly battery cable clamps and battery terminals.
4. Check alternator drive belt for excessive wear, cracks, fraying and glazed surfaces and replace if necessary. Also, check drive belt tension and adjust if necessary, as outlined under “Drive Belt Tension Adjustment.”

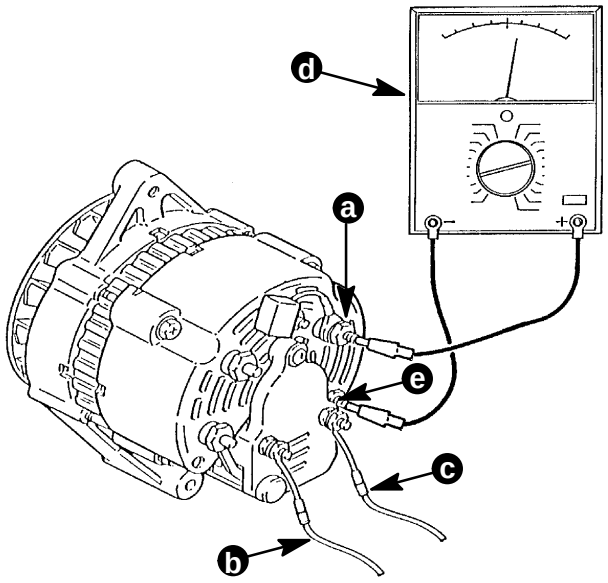
Circuitry Test

Perform the following tests, using a 0-20 volt DC voltmeter, to check that all of the circuits between the alternator and the other components within the alternator system are in good condition.

OUTPUT CIRCUIT

1. Connect positive (+) voltmeter lead to alternator output terminal and negative (–) lead to a ground terminal on alternator.

2. Wiggle engine wiring harness while observing voltmeter. Meter should indicate approximate battery voltage and should not vary. If no reading is obtained, or if reading varies, check alternator output circuit for loose or dirty connections or damaged wiring.

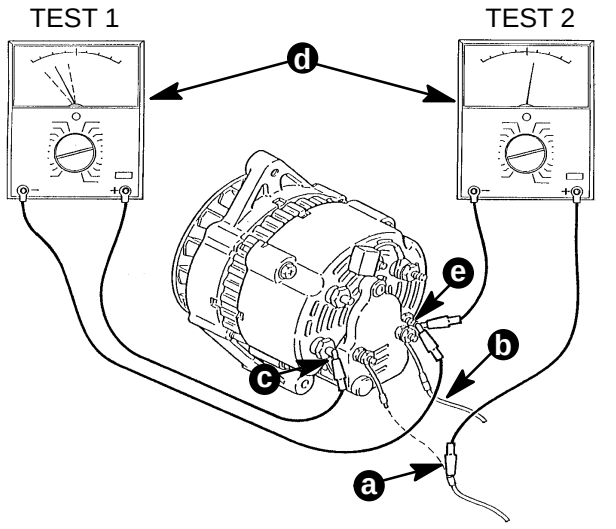


72784

a - Output Wire - ORANGE
b - Excitation Wire - PURPLE
c - Sensing Wire - RED/PURPLE
d - Voltmeter (0-20 Volts)
e - Ground

EXCITATION CIRCUIT

1. Connect positive (+) voltmeter lead to tie strap terminal on alternator and negative (–) lead to a ground terminal on alternator (Test 1).
2. Turn ignition switch to ON position and note voltmeter reading. Reading should be 1.3 to 2.5 volts.
3. If no reading is obtained, an opening exists in alternator excitation lead or in excitation circuit of regulator. Unplug PURPLE lead from regulator. Connect positive voltmeter lead to PURPLE lead and negative voltmeter leads to ground (Test 2). If voltmeter now indicates approximate battery voltage, voltage regulator is defective and must be replaced. If no voltage is indicated, check excitation circuit for loose or dirty connections or damaged wiring.
4. If reading is between .75 and 1.1 volts, rotor field circuit probably is shorted or grounded. Disassemble alternator and test rotor as outlined under “Alternator Repair,” following.
5. If reading is between 6.0 and 7.0 volts, rotor field circuit probably is open. Remove regulator and inspect for worn brushes or dirty slip rings. Replace brushes if less than 1/4 in. (6 mm) long. If brushes and slip rings are in good condition, disassemble and perform rotor test as outlined under “Component Testing - Rotor” following.



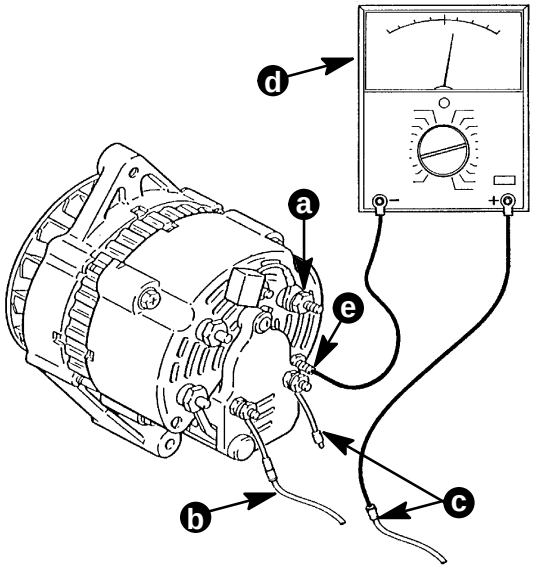
72785

a - Excitation Wire - PURPLE
b - Sensing Wire - RED/PURPLE
c - Tie Bar
d - Voltmeter (0-20 Volts)
e - Ground

SENSING CIRCUIT

1. Unplug RED/PURPLE lead from voltage regulator.

2. Connect positive (+) voltmeter lead to red/purple lead and negative (–) voltmeter lead to ground terminal.
3. Voltmeter should indicate battery voltage. If battery voltage is not present, check sensing circuit (red/purple lead) for loose or dirty connection or damaged wiring.



72786

a - Output Wire - ORANGE
b - Excitation Wire - PURPLE
c - Sensing Wire - RED/PURPLE
d - Voltmeter (0-20 Volts)
e - Ground

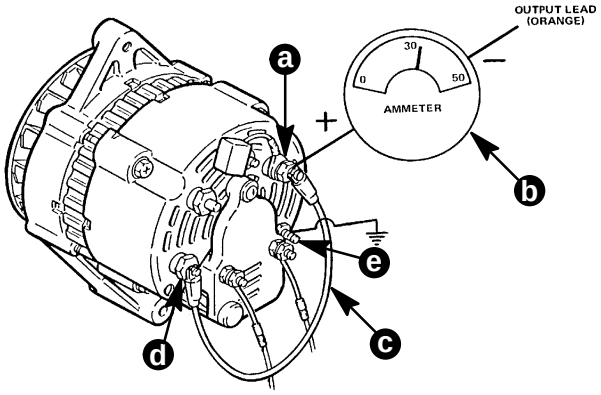
Current Output Test

Perform this test to check if alternator is capable of producing rated current output, using a 0-50 amp DC ammeter.

⚠WARNING

Be sure that engine compartment is well-ventilated and that there are no gasoline vapors present (during the test) to prevent the possibility of an explosion and/or a fire, should a spark occur.

1. Disconnect negative (–) battery cable from battery.
2. Disconnect orange lead from alternator output terminal and connect ammeter in series between lead and output terminal. Connect positive (+) side of ammeter toward output terminal.
3. Reconnect negative battery cable.
4. Remove coil wire from distributor cap tower and ground it to block. Turn on all accessories and crank engine over with starter motor for 15-20 seconds.
5. Turn off accessories and reinstall coil wire. Start engine and adjust engine speed to 1500-2000 RPM. Quickly observe ammeter. Reading should be at least 30 amps.
6. If reading is low, stop engine and connect a jumper wire between alternator output terminal and regulator terminal. Repeat Steps 4 and 5.
7. If reading is now within specifications, diodes are faulty. Disassemble alternator and replace rectifier as explained under “Alternator Repair,” following, to determine if fault is in regulator or alternator.
8. If reading is still low with jumper wire connected, perform “Voltage Output Test,” following, to determine if fault is in regulator or alternator.



72787

a - Output Wire - ORANGE
b - Ammeter (0-50 Amps)
c - Jumper Lead
d - Regulator Lead
e - Ground

Voltage Output Test

Perform this test to determine if voltage regulator is operating correctly, using a 0-20 volt DC voltmeter.

IMPORTANT: Battery MUST BE fully charged (1.260 or above specific gravity) to obtain proper voltage reading in this test. If necessary, charge battery with a battery charger or allow engine to run a sufficient length of time to fully charge battery before taking reading.

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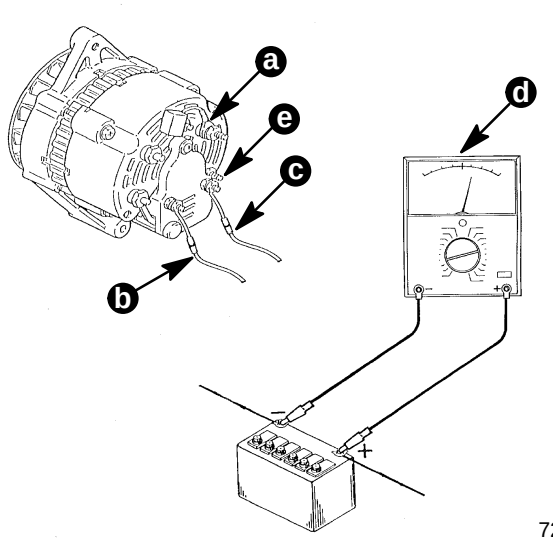
1. Connect positive (+) voltmeter lead to positive battery terminal and negative (–) voltmeter lead to negative terminal.
2. Start engine and run at fast idle until engine reaches normal operating temperature. Adjust engine speed to 1500-2000 RPM and observe voltmeter for highest reading. Reading should be between 13.9 and 14.7 volts.
3. If reading is high, check for a loose or dirty regulator ground lead connection. If connection is good (and sensing circuit checked out good in “Circuitry Test”), voltage regulator is faulty and must be replaced. Be sure to disconnect battery cables before attempting to remove regulator.



72788

a - Output Wire - ORANGE
b - Excitation Wire - PURPLE
c - Sensing Wire - RED/PURPLE
d - Voltmeter (0-20 Volts)
e - Ground

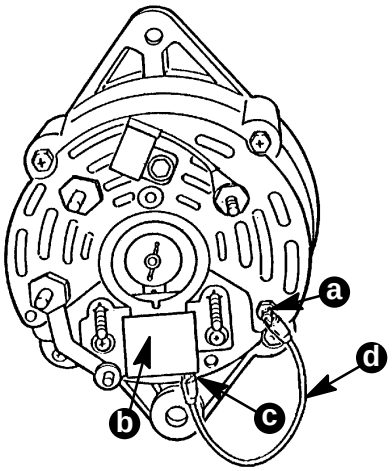
⚠ WARNING

Be sure that engine compartment is well-ventilated and that there are no gasoline vapors present (during the next steps) to prevent the possibility of an explosion and/or fire, should a spark occur.

⚠ CAUTION

DO NOT allow tie jumper wire to contact alternator end frame (in next step), as rectifier and diode assembly may be damaged.

4. Remove four nuts holding excitation and sensing wires and Phillips screw. Remove regulator cover and install wires and nuts for testing. Connect a jumper wire from the ground stud to the brush terminal on the lower right- hand side of the brush assembly. Restart engine and gradually increase engine speed to 1500 RPM while observing voltmeter. DO NOT allow voltage to exceed 16 volts.
5. If a voltmeter reading of 14.5 volts or above is now obtained, voltage regulator is faulty and must be replaced. If voltmeter reading is below 14.5 volts, inspect brushes and slip rings for wear, dirt or damage. If brushes and slip rings are good, alternator is faulty internally. Disassemble alternator and test components, as outlined under “Alternator Repair,” following.



72971

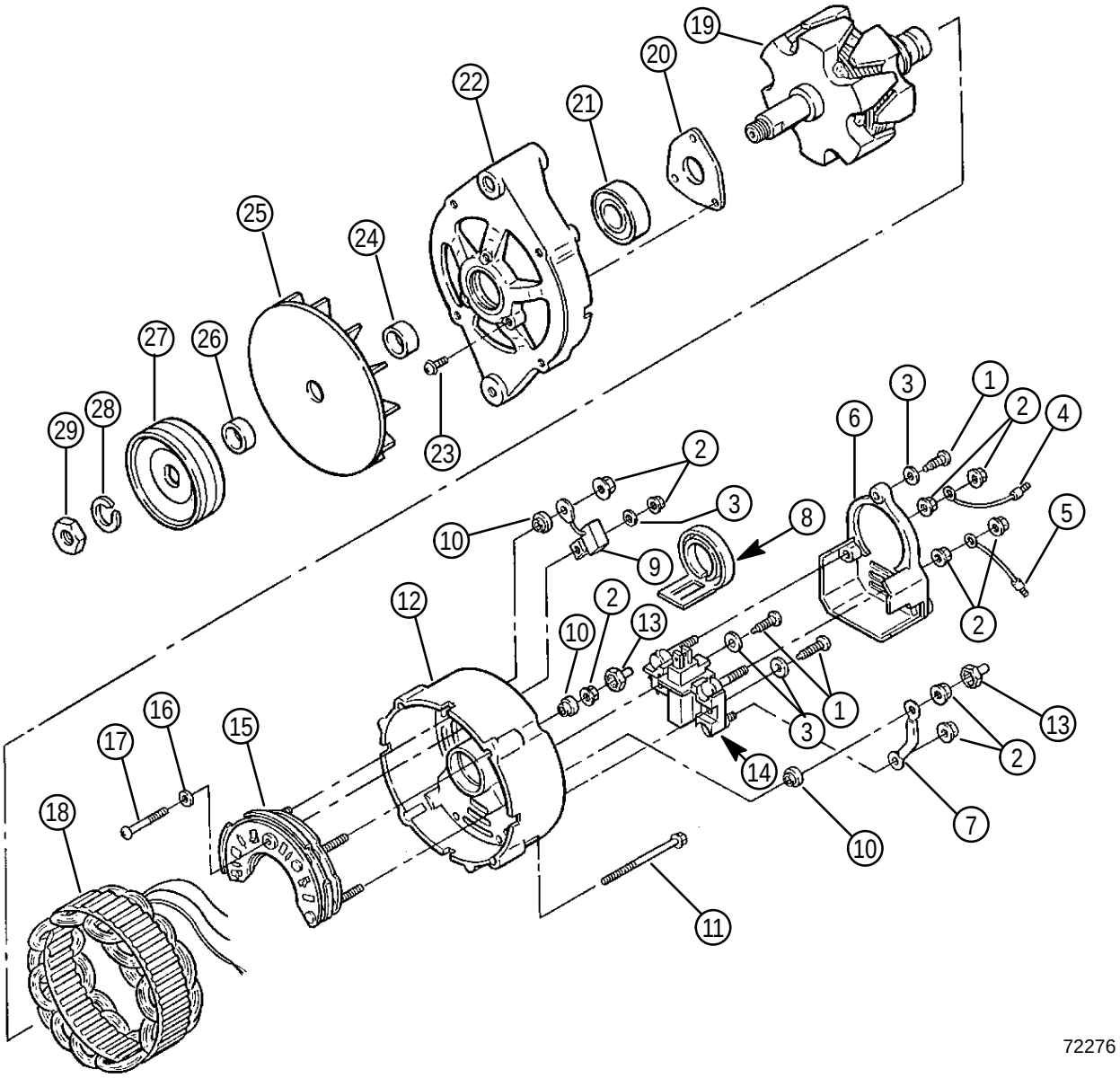
a - Ground
b - Brush / Regulator Assembly
c - Brush Terminal
d - Jumper Wire (Solder Connection Ground)

Alternator Repair

Removal

1. Disconnect negative (–) battery cable from battery.
2. Disconnect wiring harness from alternator.
3. Remove alternator brace-to-alternator attaching bolt, washer(s) and spacer (if used).
4. Loosen alternator brace-to-engine attaching bolt and alternator mounting bolt, then pivot alternator inward and remove alternator drive belt.
5. Remove alternator mounting bolt, washers (if used), spacer and nut, and remove alternator.

Exploded View



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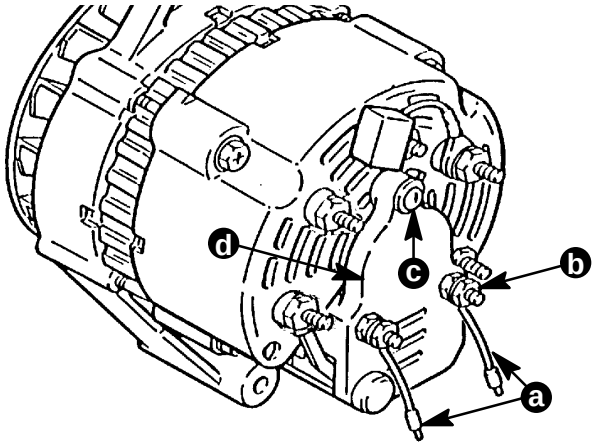
1 - Screws (3)
2 - Nut (9)
3 - Flat Washer (4)
4 - Sensing Wire (RED / PURPLE)
5 - Excitation Wire (PURPLE)
6 - Cover
7 - Tie Strap
8 - Rubber Gasket
9 - Condenser
10 - Insulator
11 - Bolt (4)
12 - End Frame (Rear)
13 - Cap (2)
14 - Brush / Regulator Assembly
15 - Rectifier Assembly
16 - Flat Washer
17 - Screw
18 - Stator
19 - Rotor And Slip Ring
20 - Retaining Plate
21 - Front Bearing
22 - End Frame (Front)
23 - Screw (3)
24 - Fan Spacer
25 - Fan
26 - Pulley Spacer
27 - Pulley
28 - Lockwasher
29 - Nut

Disassembly

IMPORTANT: The following instructions are for complete disassembly and overhaul of the alternator. In many cases, however, complete disassembly of alternator is not required and, in those cases, it is necessary only to perform the operations required to repair or replace the faulty part.

1. Mount alternator in a vise so that rear end frame is facing you.
2. Disconnect regulator leads from terminals on rear end frame. Remove four nuts, Phillips head screw and two regulator leads. Then pull regulator cover away from rear end frame.

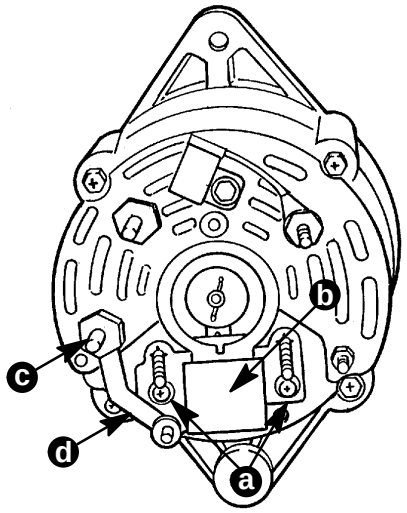


72963

a - Regulator Leads
b - Nuts (4)
c - Phillips Head Screw
d - Regulator Cover

3. Remove stud cover insulator, two nuts and tie strap from brush/regulator assembly.

4. Remove two brush/regulator attaching screws and remove brush/regulator assembly.



72823

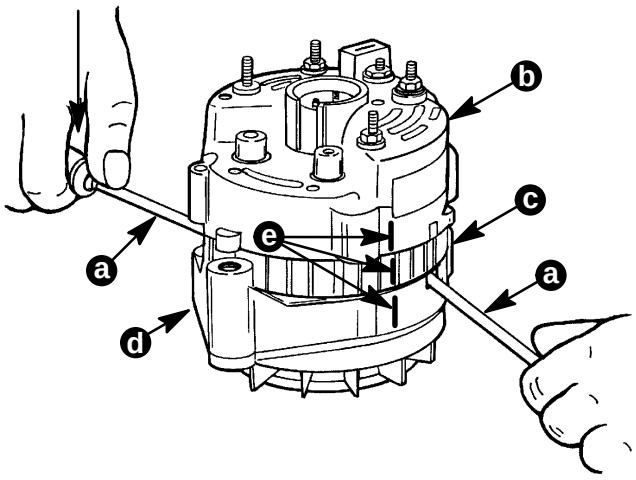
a - Screws
b - Brush / Regulator Assembly
c - Stud Cover Insulator
d - Tie Strap

5. Scribe a mark on rear end frame, stator and front end frame to ensure proper reassembly later.

6. Remove four screws which secure end frames and stator together.

IMPORTANT: DO NOT insert screwdriver blades more than 1/16 in. (1.5 mm) into openings (in next step), as stator windings may be damaged.

7. Separate rear end frame and stator assembly from front end frame and rotor assembly using two thin blade screwdrivers (positioned 180 degrees apart from one another) at the locations shown. Use the two slots shown to initially separate units.

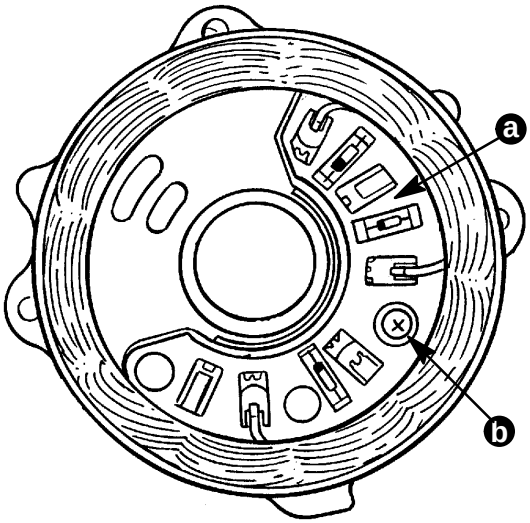


72824

a - DO NOT Insert Screwdriver Blades More Than 1/16 In. (1.5 mm) Into Slots.
b - Rear End Frame
c - Stator
d - Front End Frame
e - Scribe Marks

8. Place rear end frame and stator assembly on the bench with stator downward. Be sure that bench is clean and free of metal chips. Remove nuts, washers, insulators and condenser from output and ground studs.

9. Turn end frame over (stator upward) and remove one Phillips head screw which secures rectifiers to end frame.

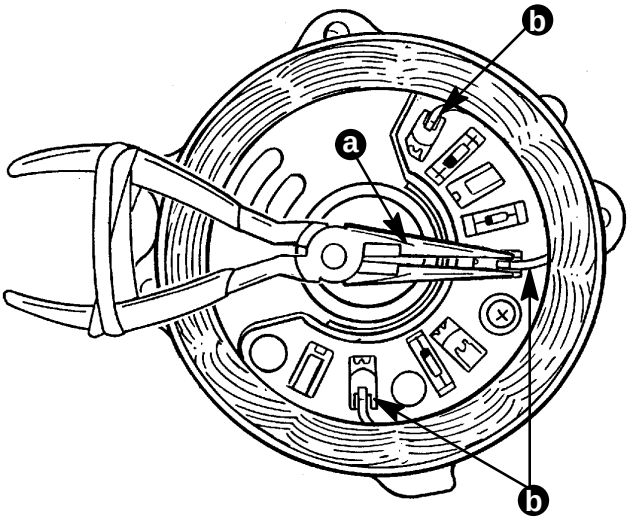


72826

a - Rectifier Assembly
b - Phillips Head Screw

10. Separate stator and rectifier assembly from rear end frame using screwdriver slots.

11. Unsolder the three stator leads from the rectifier heat sink. Place a needle nose pliers on diode terminal between solder joint and diode body to help prevent heat damage to diodes. Unsolder joints as quickly as possible and allow diode terminal to cool before removing pliers.



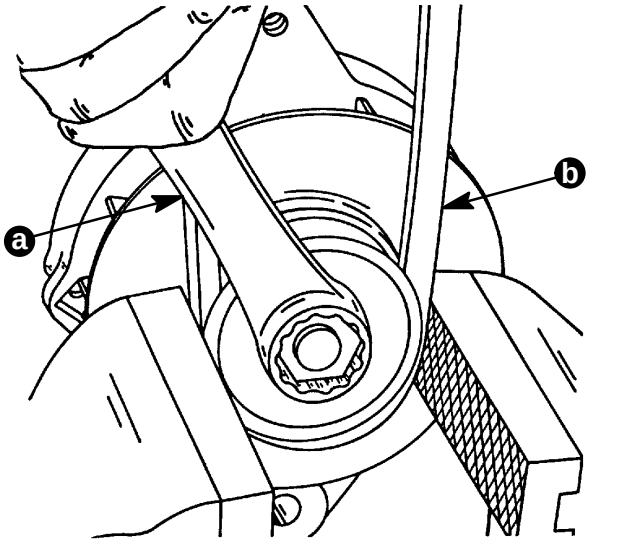
72827

a - Heat Sink
b - Stator Leads (3)

IMPORTANT: With alternator disassembled to this point, stator, rectifier, diodes, and rotor may be tested, as explained under "Component Testing," following.

IMPORTANT: DO NOT clamp vise on rotor pole pieces when removing pulley nut (in next step), as pole pieces may be distorted.

12. Remove pulley retaining nut by clamping pulley in a vise (using an oversize V-belt or protective jaws to protect pulley) and turning nut counterclockwise with a wrench. Remove lockwasher and slide pulley and fan from shaft. If pulley is difficult to remove, it may be necessary to use a universal puller.



72828

a - Wrench
b - Over-Sized Belt To Protect Pulley

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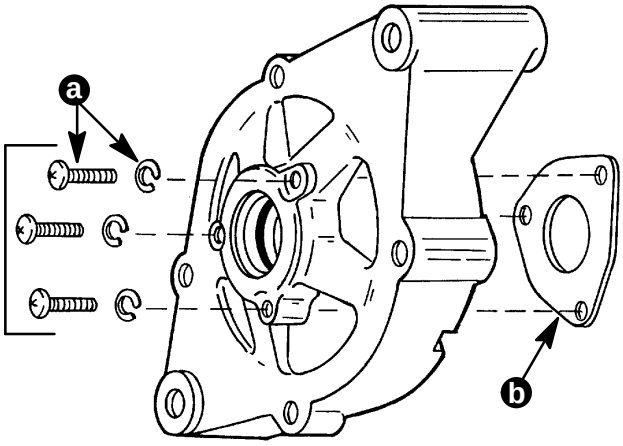
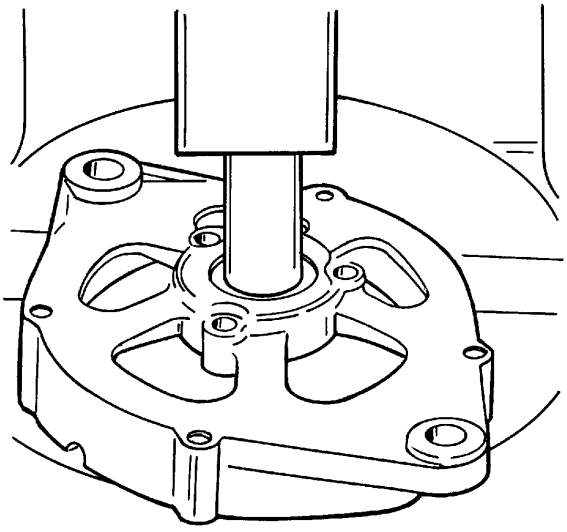
13. Remove the three phillips head screws and lockwashers which secure the front bearing retaining plate.



72829

a - Phillips Head Screws and Lockwashers
b - Front Bearing Retaining Plate

14. Remove front bearing from front end frame using an arbor press and a suitable size mandrel. (Discard bearing.)



72830

Removing Front Bearing from Front End Frame

15. If rotor slip rings or rear bearing requires replacement, entire rotor must be replaced. Parts cannot be purchased separately.

Cleaning and Inspection

1. Clean all parts with a clean, soft cloth. DO NOT use solvent, or electrical components may be damaged.
2. Inspect the following parts for wear and damage:
   a. **Brush/regulator assembly** - inspect for cracked casing, damaged brush leads, poor brush lead solder connections, weak or broken brush springs or worn brushes. Replace brush set if brushes are less than 1/4 in. (6 mm) long.
   b. **Rotor** - inspect for stripped threads, scuffed pole piece fingers or damaged bearing surfaces (because of bearing turning on shaft).
   c. **Rotor-slip rings** - clean slip rings with 400 grain (or finer) polishing cloth while spinning rotor in a lathe. Blow off dust with compressed air. Inspect slip rings for grooves, pits, flat spots or out-of-round [.002 in. (0.051 mm) maximum] and replace rotor, if present.
   d. **Rotor shaft and front end bearings** - inspect for damaged seals, lack of lubrication, discoloration (from overheating) and excessive side or end play. Bearing should turn freely without binding or evidence of rough spots.
   e. **Stator** - inspect for damaged insulation or wires; also inspect insulating enamel for heat discoloration, as this is usually a sign of a shorted or grounded winding or a shorted diode.
   f. **Front and rear end frames** - inspect for cracks, distortion, stripped threads or wear in bearing bore (from bearing outer race spinning in bore). End frame(s) MUST BE replaced, if bearing has spun. Also, inspect bearing retainer recess in front end frame for damage.
   g. **Fan** - inspect for cracked or bent fins, broken welds (bi-rotational fan only) or worn mounting hole (from fan spinning on shaft).
   h. **Pulley** - inspect pulley mounting bore end for wear. Inspect drive surface of pulley sheaves for trueness, excessive wear, grooves, pits, nicks and corrosion. Repair damaged surfaces, if possible, with a fine file and a wire brush or replace pulley, if beyond repair. Drive surfaces MUST BE perfectly true and smooth or drive belt wear will be greatly accelerated.

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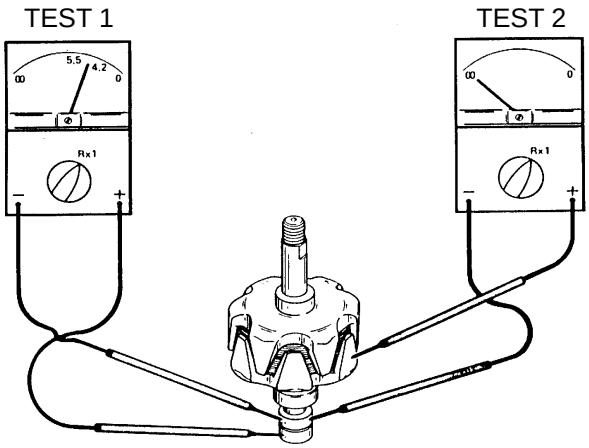
Component Testing

ROTOR

1. Test rotor field circuit for opens, shorts or high resistance (Test 1), using an ohmmeter (set on R x1 scale), as follows:



72831

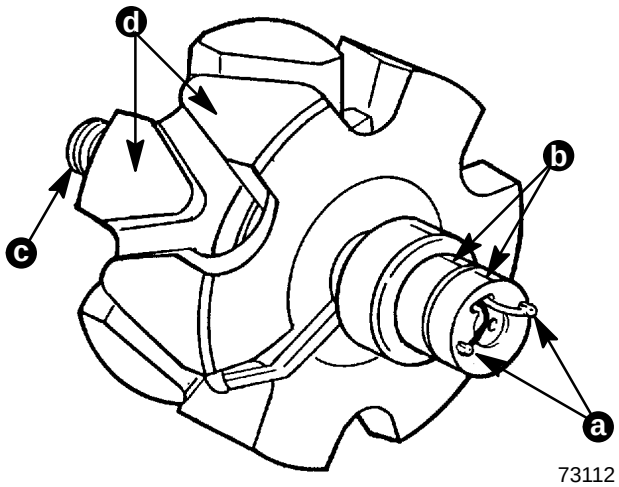
Testing Rotor Field Circuit

   a. Connect one ohmmeter lead to each slip ring.

   b. Ohmmeter reading should be 4.2 to 5.5 ohms with rotor at room temperature 70-80°F (21-26°C).

   c. If reading is high or infinite (no meter movement), high resistance or an open exists in the field circuit. Check for poor connections between field winding leads and slip ring terminals. If cause for open or high resistance cannot be found, connect ohmmeter directly to slip ring terminals. If correct reading is now obtained, or if reading is still high or infinite, replace complete rotor assembly.

   d. If reading is low, a short exists in the field circuit. Inspect slip rings to be sure that they are not bent and touching outer slip ring. Also, be sure that excess solder is not shorting terminals to aft slip ring. If cause for short cannot be found, unsolder field winding leads from slip ring terminals and connect ohmmeter directly to leads. If correct reading is now obtained, or if reading is still low, slip rings and rotor field windings are shorted, and complete rotor assembly must be replaced.



73112

a - Field Winding Leads
b - Slip Rings
c - Rotor Shaft
d - Pole Pieces

2. Test rotor field circuit for grounds (Test 2), using an ohmmeter (set on R x1 scale) as follows:

   a. Connect one lead of ohmmeter to either slip ring and the other lead to rotor shaft or pole pieces.

   b. Meter should indicate no continuity (meter should not move).

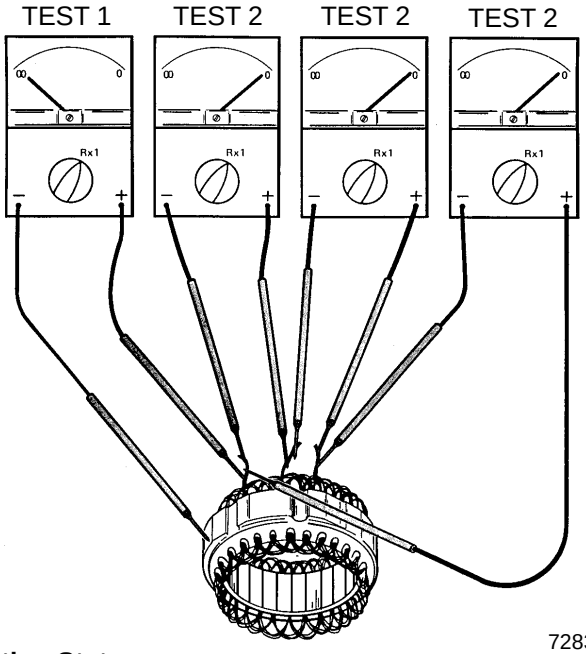
   c. If continuity does exist, complete rotor assembly must be replaced.

IMPORTANT: If alternator has output at low speeds, but no output at high speeds, rotor field winding may be shorting or grounding out, due to centrifugal force. Replace rotor if all other electrical components test good.

STATOR

IMPORTANT: Stator leads MUST BE disconnected from rectifier for this test.

1. Test stator for grounds (Test 1), using an ohmmeter (set on R x1 scale) as follows:
   a. Connect one lead of ohmmeter to one of the stator leads and the other lead to stator frame. Be sure that lead makes good contact with frame.
   b. Meter should indicate no continuity (meter should not move). If continuity does exist, stator is grounded and must be replaced.
2. Test for opens in stator (Test 2), using an ohmmeter (set on R x1 scale) as follows:
   a. Connect ohmmeter between each pair of stator windings (three different ways).
   b. Continuity should be present in all three cases (meter should move). If it does not, one or more of the windings are open and stator must be replaced.



Testing Stator

3. A short in the stator is difficult to detect without special equipment, because of the low windings resistance. If all other electrical components test out good, and alternator fails to produce rated output, stator probably is shorted and should be replaced. Also, examine stator for heat discoloration, as this usually is a sure sign of a short.

RECTIFIER AND DIODE ASSEMBLY

NOTE: *Failure of any component in tests following will require replacement of entire rectifier assembly.*

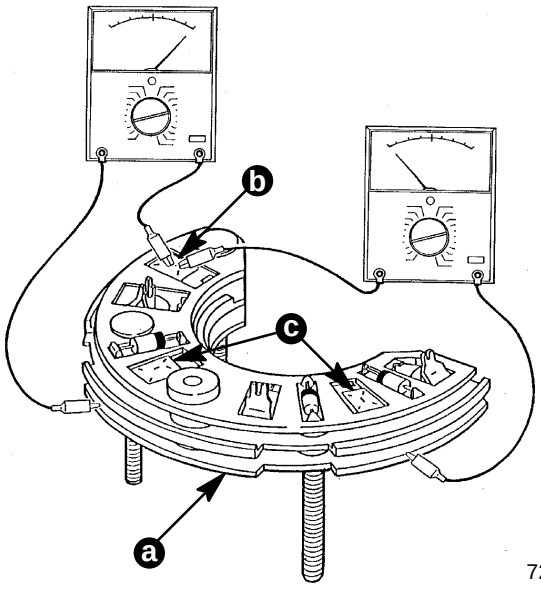
NEGATIVE (–) RECTIFIER

IMPORTANT: Rectifier MUST BE disconnected from stator for this test.

⚠CAUTION

DO NOT use a test instrument with more than a 12 volt source (in the following test), as rectifier may be damaged.

1. Connect one lead of an ohmmeter (set on R x1 scale) to negative (–) rectifier heat sink and the other lead to one of the rectifier terminals. Note the reading.
2. Reverse leads and again note reading.
3. Meter should indicate a high or infinite resistance (no meter movement) when connected one way and a low reading when connected the other. If both readings are high or infinite, rectifier is open. If both readings are low, rectifier is shorted.
4. Repeat Steps 1 through 3 for two other rectifiers in heat sink.
5. Replace assembly if any of the rectifiers is shorted or open.



a - Heat Sink
b - Rectifier Terminal
c - Test These Two Rectifiers In The Same Manner

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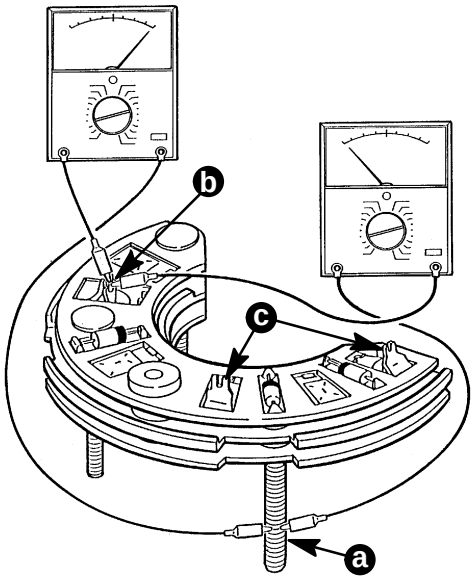
POSITIVE (+) RECTIFIER AND DIODES

⚠ CAUTION

DO NOT use a test instrument with more than a 12 volt source (in the following test), as rectifier may be damaged.

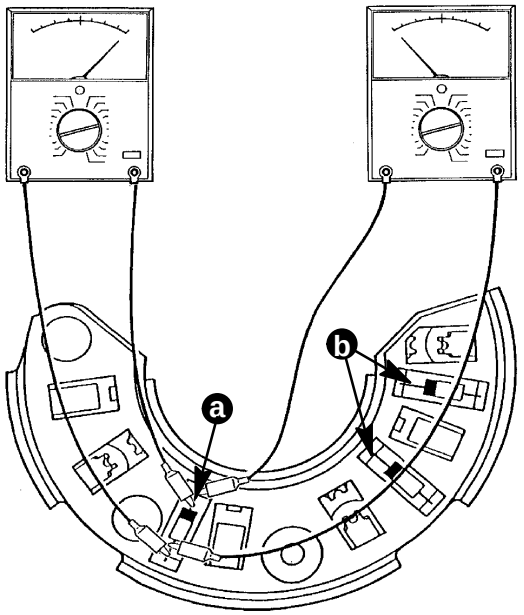
1. Connect one lead of an ohmmeter (set on R x1 scale) to 1/4 in. stud on positive (+) rectifier heat sink and the other lead to one of the rectifier terminals. Note the meter reading.
2. Reverse leads and again note reading.
3. Meter should indicate a high or infinite resistance (no meter movement) when connected one way and a low reading when connected the other. If both readings are high or infinite, rectifier is open. If both readings are low, rectifier is shorted.
4. Repeat Steps 1 through 3 for two other rectifiers in heat sink.



72834

a - Stud
b - Rectifier Terminal
c - Repeat Test Between These Terminals And Stud

5. Replace assembly if any one of the rectifiers is shorted or open.
6. Connect one lead of an ohmmeter (set on R x1) to the common side of the diode and the other lead to the other side, of one of the three diodes.



72148

a - Common Side Of Diode Circuit Board
b - Repeat Test For Two Diodes

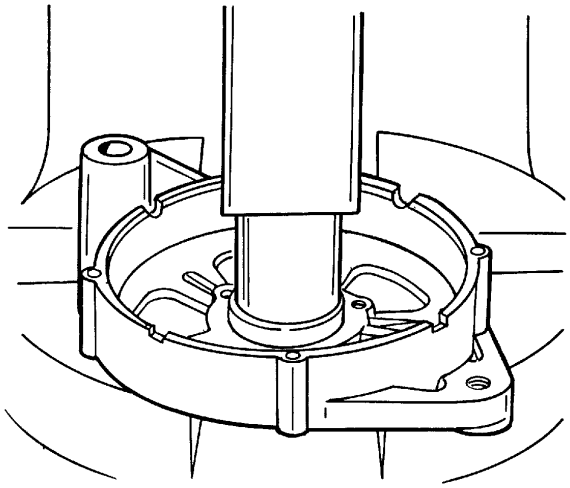
7. Reverse leads and again note reading.
8. Meter should indicate a high or infinite resistance (no meter movement) when connected one way and a low reading when connected the other. If both readings are high or infinite, diode is open. If both readings are low, diode is shorted.
9. Repeat Steps 6 through 8 for the other two diodes.
10. Replace rectifier assembly if any one of the diodes is shorted or open.

CONDENSER

1. Using magneto analyzer and accompanying instructions, perform the following condenser tests:
   a. Condenser Capacity Test (must be .5 mfd).
   b. Condenser Short or Leakage Test.
   c. Condenser Series Resistance Test.
2. Replace condenser if test results are not within specifications.

Reassembly

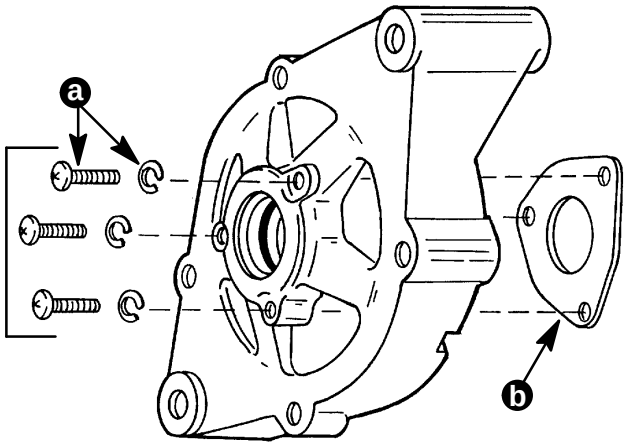
1. Install new front bearing into front end frame bearing bore using an arbor press. If necessary, use a bearing driver that contacts outer race only.



72835

Installing Front Bearing into Front End Frame

2. Install front bearing retaining plate using three Phillips head screws and lockwashers.



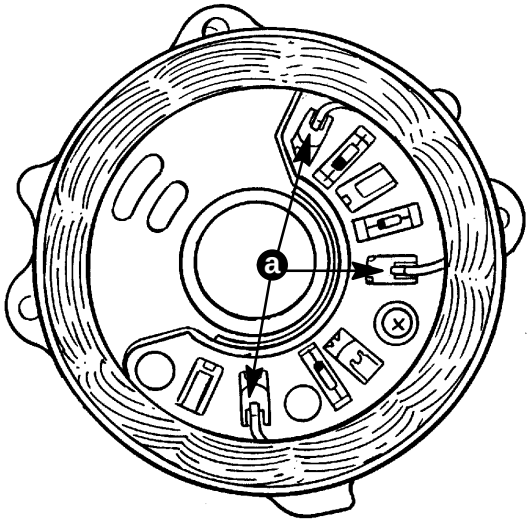
72829

a - Philips Head Screws And Lockwashers
b - Front Bearing Retaining Plate

3. Slide front end frame over rotor.

IMPORTANT: DO NOT clamp vise on rotor pole pieces when tightening pulley nut (in next step), or pole pieces may be distorted.

4. Slide fan spacer onto rotor shaft. Install fan, pulley, lockwasher and nut on shaft. Clamp pulley in a vise, using protective jaws or an old oversize V-belt to protect pulley, and torque nut to specifications. Tighten vise only enough to allow tightening of nut, as excessive tightening may distort pulley.
5. Assemble stator to rectifier by soldering the three leads to the three rectifier terminals.



72826

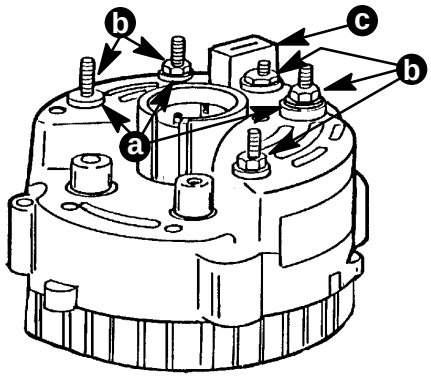
a - Stator Lead Connections

NOTE: *Be sure to connect leads to their original positions.*

6. Install assembled stator and rectifier assembly into rear end frame, aligning scribe marks on each (scribed during disassembly), and install Phillips head screw and washer to retain.

IMPORTANT: The insulating washers MUST BE installed as shown or damage to the alternator will result.

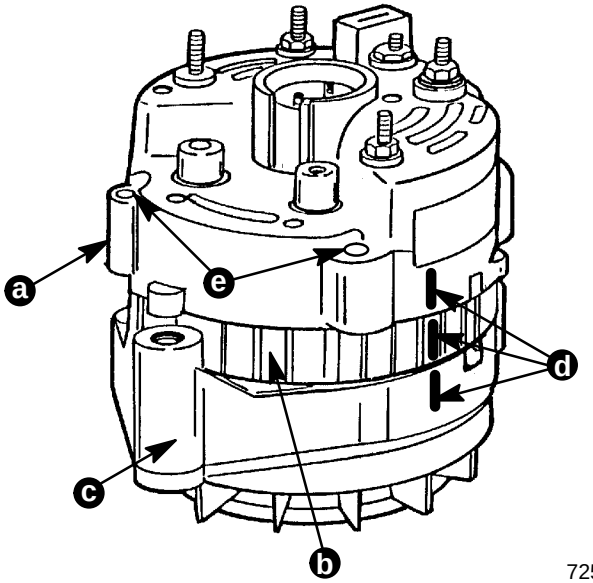
7. Position stator down with rear end frame up and reinstall insulators, nuts and condenser.



72561

a - Insulators (3)
b - Nuts (5) - ONE REMOVED
c - Condenser

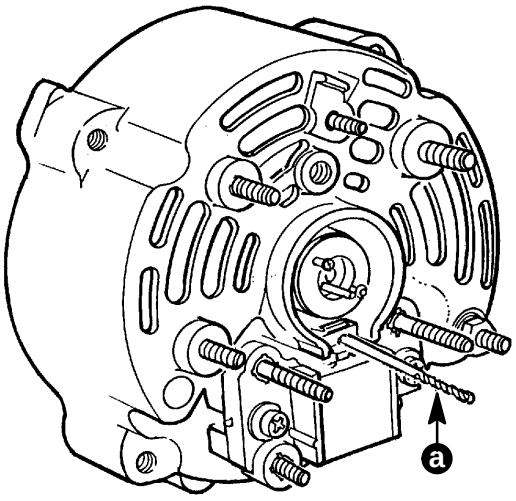
8. Position rear end frame and stator assembly over front end frame and rotor assembly and align scribe marks on each (scribed during disassembly). Hand-press end frames together, then install four screws. Tighten screws securely.



72561

a - Rear End Frame
b - Stator
c - Front End Frame
d - Scribe Marks
e - Insert Screws (4) (Two Hidden)

9. Depress brushes flush with top of brush holder and insert a #54,.050 in. drill bit or smaller into hole in brush holder to hold brushes compressed during reassembly.

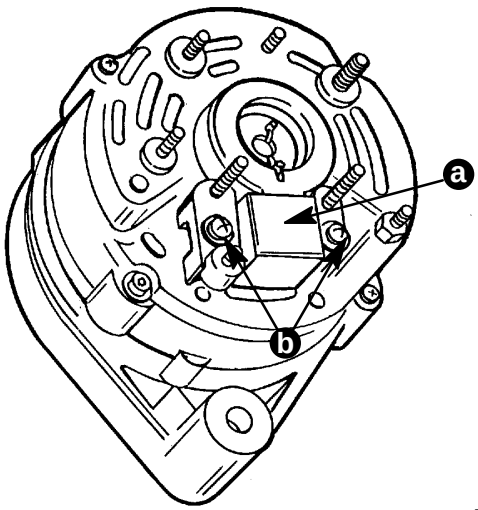


72836

a - Drill Bit

NOTE: *Rubber gasket shown removed for clarity.*

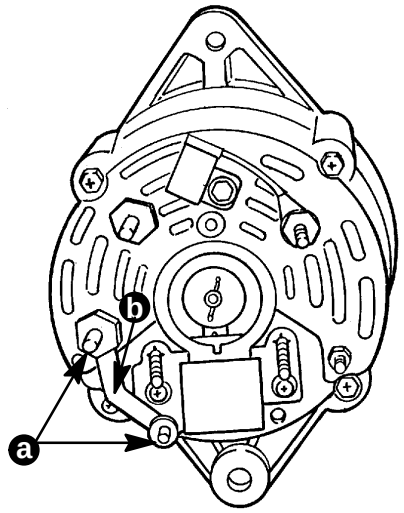
10. Install brush/regulator assembly in rear end frame cavity and secure with two mounting screws, as shown. Tighten screws securely. Remove drill bit to release brushes against slip rings.



72837

a - Brush / Regulator Assembly
b - Mounting Screws

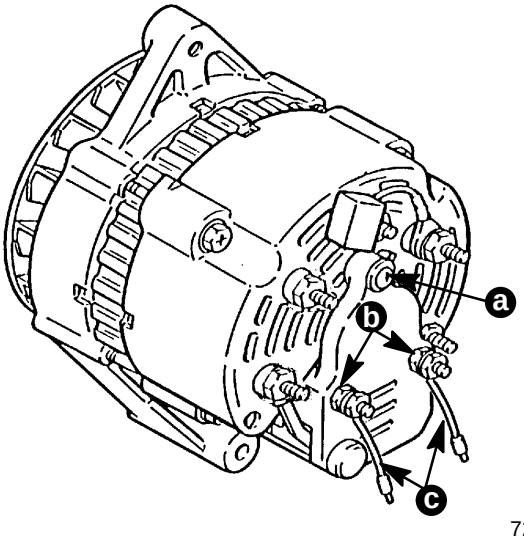
11. Install tie strap to rectifier stud and stud on brush/ rectifier assembly. Tighten nuts securely.



72823

a - Studs
b - Tie Straps

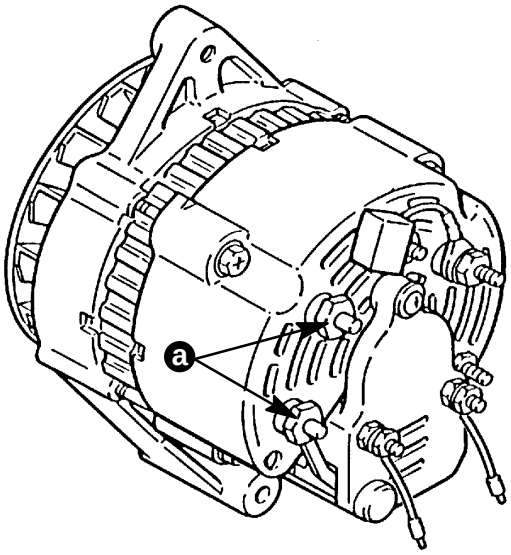
12. Install cover with one phillips head screw and two nuts. Install two leads with nuts.



72963

a - Phillips Head Screw
b - Nuts (4)
c - Leads

13. Install insulator caps.

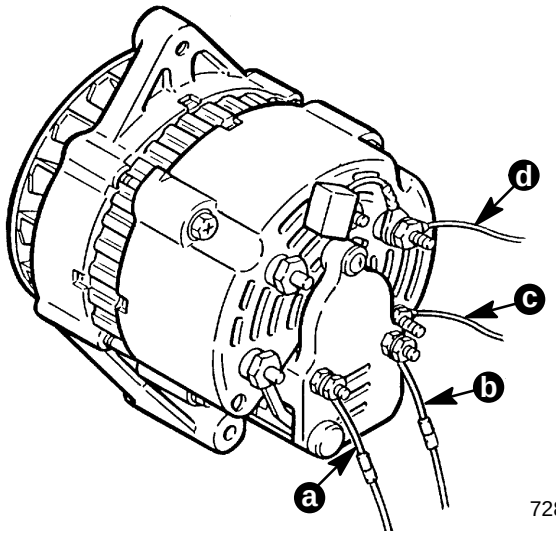


72078

a - Insulator Caps

Installation

1. Position alternator in mounting bracket and install mounting bolt, washers (if used), spacer and nut. Place washers (if used), on each side of spacer. DO NOT tighten securely at this time.
2. Fasten alternator brace to alternator with bolt, washers and spacer (if used). DO NOT tighten bolt at this time.
3. Position alternator drive belt on pulleys and adjust tension as explained under “Drive Belt Tension Adjustment.”
4. Reconnect wiring harness to alternator and negative battery cable to battery.



72838

a - Excitation Lead -(PURPLE)
b - Sensing Lead - (RED / PURLPE)
c - Ground Lead - (BLACK)
d - Output Lead - (ORANGE)

Prestolite 65 Amp Alternator

Replacement Parts Warning

⚠ WARNING

Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

Specifications

Description	Specification
Excitation Circuit	1.5 to 3.0 Volts
Current Output	51 Amp. Min.
Voltage Output	13.8 to 14.8 Volts
Condenser Capacity	.5 MFD
Minimum Brush Length	3/16 in. (5 mm)

Tools/Sealants

Description	Part Number
Magneto Analyzer	91-76032
Universal Puller Plate	91-37241
Multi-Meter / DVA Tester	91-99750
Quicksilver Liquid Neoprene	92-27511--2
Ammeter (0-50 Amp.)	Obtain Locally

Torque Specifications

Fastener Location	In. Lb.	Ft. Lb.	N·m
Housinhg Screws	55		5.6
Pulley Nut		35-50	48-68
Front Bearing Screws	30		2.8
Alternator Mount		35	48
Adjustment Bolt		16	28
V-Belt Tension (Note)	Depress 1/4 in. (13mm)		

Description

The alternator has a rotor, which is supported in two end frames by ball bearings, and is driven by a pulley at approximately twice engine speed. The rotor contains a field winding that is enclosed between two multiple-finger pole pieces. The ends of the field winding are connected to two brushes (mounted in the rear end frame) which make continuous sliding (or slipping) contact with the slip rings. The current (flowing through the field winding) creates a magnetic field that causes the adjacent fingers of the pole pieces to become alternate north and south magnetic poles.

A 3-phase stator is mounted directly over the rotor pole pieces and between two end frames. It consists of three windings wound 120 degrees electrically out-of-phase on the inside of a laminated core. The windings are all connected together on one end, while the other ends are connected to a full-wave rectifier bridge.

The rectifier bridge contains six rectifiers which are arranged so that current flows from ground, through the stator and to the output terminal, but not in the opposite direction.

When current is supplied to the rotor field winding, and the rotor is turned, the movement of the magnetic fields created induces an alternating current into the stator windings. The rectifier bridge then changes this alternating current to direct current which appears at the output terminal. A diode trio also is connected to the stator windings to supply current to the regulator and the rotor field during operation.

Voltage output of the alternator is controlled by regulating the current supplied to the rotor field. This is accomplished by a transistorized voltage regulator that senses the voltage at the battery and regulates the field current to maintain alternator voltage within prescribed limits for properly chargi[illegible] battery. Cur-

rent output of the alternator does not require regulation, as maximum current output is self-limited by the design of the alternator. As long as the voltage is regulated within the prescribed limits, the alternator cannot produce excessive current. A cut-out relay in the voltage regulator also is not required, as the rectifier diodes (which allow current to flow in one direction only) prevent the battery from discharging back through the stator.

Due to the lack of residual magnetism in the rotor pole pieces, a small amount of current must be supplied to the rotor field to initially start the alternator charging. This is accomplished by means of an excitation circuit in the regulator which is connected to the ignition switch. Once the alternator begins to produce output, field current is supplied solely by the diode trio, as explained, preceding.

The alternator also is equipped with a fan (mounted on the rotor shaft) which induces air flow through the alternator to remove the heat created by the rectifiers and stator. A capacitor protects the rectifier system from high voltages and suppresses radio noise.

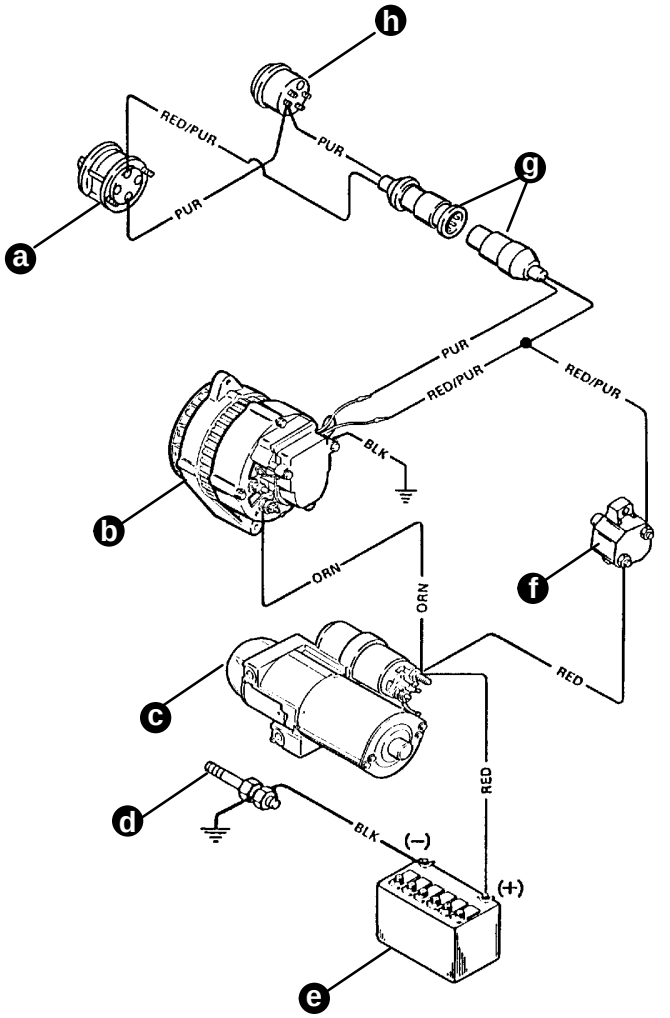
Precautions

The following precautions MUST BE observed when working on the alternator system. Failure to observe these precautions may result in serious damage to the alternator or alternator system.

1. DO NOT attempt to polarize the alternator.
2. DO NOT short across or ground any of the terminals on the alternator, except as specifically instructed in the “Troubleshooting Tests.”
3. NEVER disconnect the alternator output lead or battery cables when the alternator is being driven by the engine.
4. NEVER disconnect regulator lead from alternator regulator terminal when the alternator is being driven by the engine.
5. ALWAYS remove negative (–) battery cable from battery before working on alternator system.
6. When installing battery, BE SURE to connect the positive (+) battery cable to the positive (+) battery terminal and the negative (–) (grounded) battery cable to negative (–) battery terminal.
7. If a charger or booster battery is to be used, BE SURE to connect it in parallel with existing battery (positive to positive; negative to negative).

System Components

The alternator system consists of the alternator, battery, the ignition switch and the wiring which connects these components.



73079

a - Ingition Switch
b - Alternator
c - Starter Motor
d - Ground Stud
e - Battery
f - Circuit Breaker
g - Harness Plug
h - Battery Meter

Periodic Maintenance

The following maintenance check should be performed every 50 hours or 60 days (whichever comes first) in fresh water areas or every 25 hours or 30 days in salt water areas.

⚠CAUTION

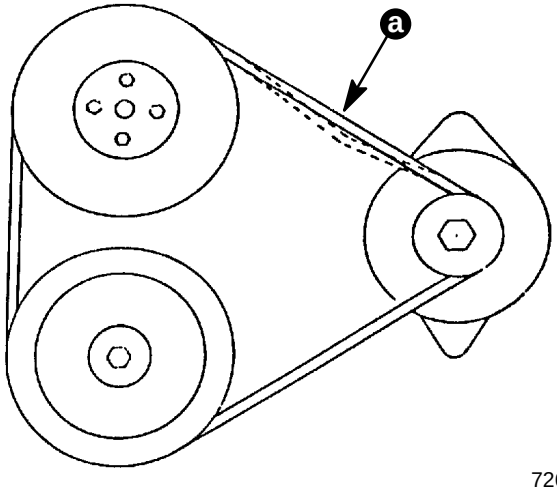
Remove all battery cables from battery (before conducting the following check) to prevent accidentally shorting out electrical system.

1. Inspect entire alternator system for corroded or loose connectors.
2. Check wiring for frayed or worn insulation.
3. Check alternator drive belt for excessive wear, cracks, fraying and glazed surfaces. Also, check drive belt tension and adjust, if necessary, as explained under “Drive Belt Tension Adjustment.”
4. Check alternator mounting bolts for adequate tightness.
5. Inspect slip ring end frame flame arrestor screen for debris and clean, if necessary, using compressed air or a cloth. Screen MUST BE clean, or alternator may overheat.

Drive Belt Tension Adjustment

V-Belt

1. Install drive belt on pulleys and adjust tension as follows:
   a. Pivot alternator away from engine, as required, until correct tension is obtained as shown. Belt should depress 1/4 in. (6 mm).



72669

a - Check Point

   b. After obtaining correct tension, securely retighten alternator brace attaching bolts and alternator mounting bolts.

Troubleshooting Tests (Alternator on Engine)

Use the following tests in conjunction with the “Troubleshooting” in Section 1. Before proceeding with the tests, however, perform the following checks to eliminate possible problem areas. Also observe “Precautions,” preceding, to prevent damage to alternator system.

1. If problem is an undercharged battery, check to ensure that undercharged condition has not been caused by excessive accessory current draw or by accessories which have accidentally been left on. Also, check that undercharged condition has not been caused by running engine at too low a speed for extended periods of time.
2. Check physical condition and state of charge of battery, as outlined in “Battery - Storage” in Section 4A. Battery MUST BE at least 75% (1.230 specific gravity) of fully charged to obtain valid results in the following tests. If not, charge battery before testing system.
3. Inspect entire alternator system wiring for defects. Check all connections for tightness and cleanliness, particularly battery cable clamps and battery terminals.
4. Check alternator drive belt for excessive wear, cracks, fraying and glazed surfaces and replace if necessary. Also, check drive belt tension and adjust if necessary, as outlined under “Drive Belt Tension Adjustment.”

Circuitry Test

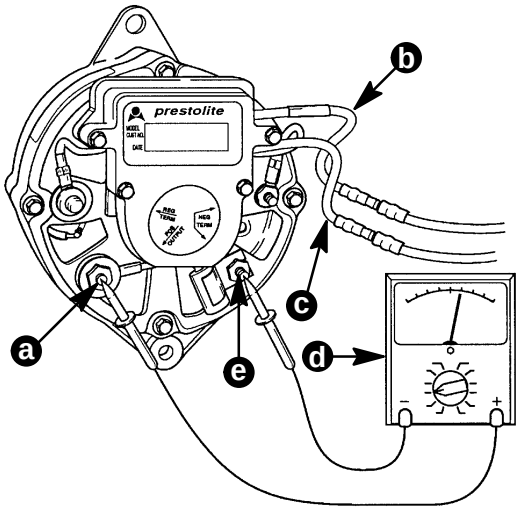
Perform the following tests, using a 0-20 volt DC voltmeter, to check that all of the circuits between the alternator and the other components within the alternator system are in good condition.

⚠ WARNING

Be sure that engine compartment is well-ventilated and that there are no gasoline vapors present (during the test) to prevent the possibility of an explosion and/or a fire, should a spark occur.

ALTERNATOR OUTPUT TEST

1. Connect positive (+) voltmeter lead to alternator output terminal (orange wire) and negative (–) lead to a ground terminal on alternator. With engine running about 1500 RPM and all accessories turned on, voltage should be between 13.8-14.8.
2. If voltage output does not fall within specifications, alternator should be tested for probable cause and disassembled for repair.



a - Output Wire (ORANGE)
b - Excitation Wire (PURPLE)
c - Sensing Wire (RED / PURPLE)
d - Voltmeter
e - Ground

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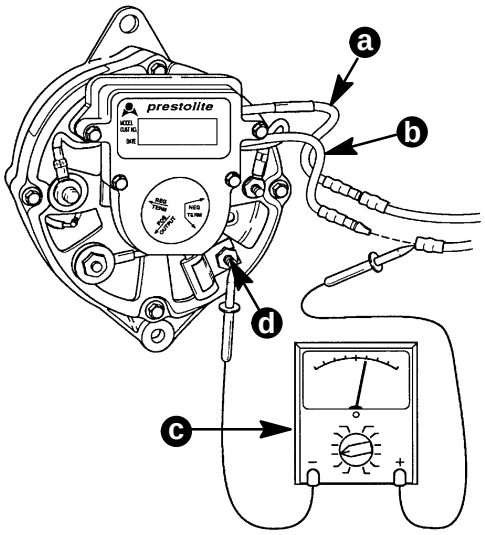
HARNESS VOLTAGE TEST

With ignition off, unplug red/purple wire and check for battery voltage at harness wire. No voltage at harness wire indicates wiring harness is “open” and should be repaired or replaced.

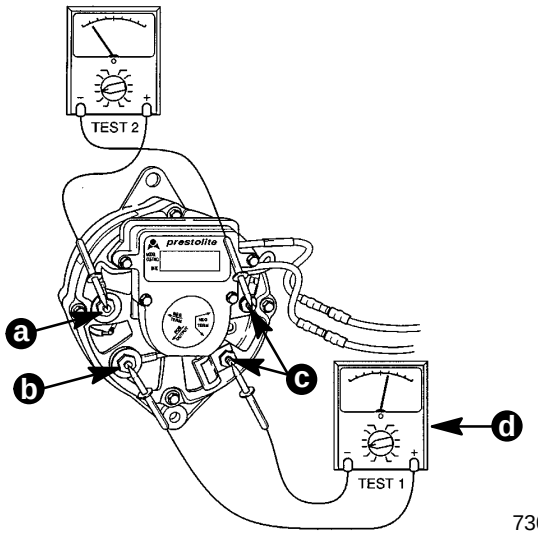


73082

a - Output Wire (ORANGE)
b - Sensing Wire (RED / PURPLE)
c - Voltmeter (0-20 Volts)
d - Ground

OPEN DIODE-TRIO TEST

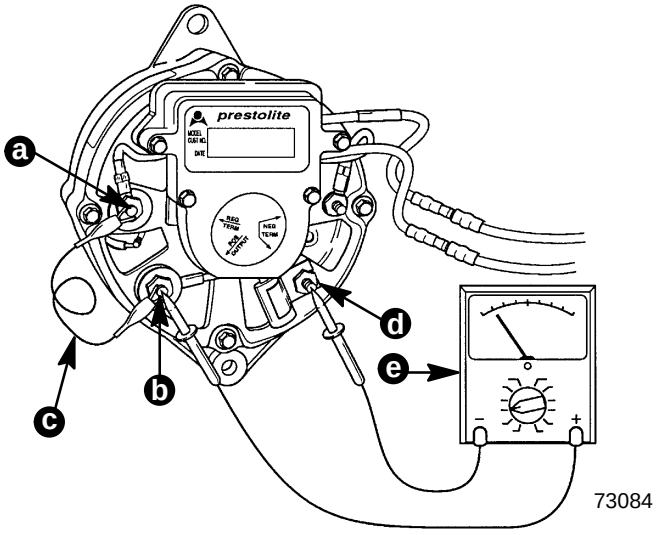
1. With ignition on and engine not running, check for battery voltage at alternator output terminal (Test 1) and 1.5 to 3.0 volts at regulator terminal (Test 2).



73083

a - Regulator Terminal
b - Output Terminal
c - Ground
d - Voltmeter (0-20 Volts)

2. Connect a jumper wire between regulator and output terminal. Start engine and run at idle. If charging voltage (13.8-14.8 volts) is present at output terminal, the diode-trio is probably defective and alternator should be removed for repair.



73084

a - Regulator Terminal
b - Output Terminal
c - Ground
d - Jumper Lead
e - Voltmeter (0-20 Volts)

CURRENT OUTPUT TEST

Perform this test to check if alternator is capable of producing rated current output, using a 0-50 amp DC ammeter.

⚠WARNING

Be sure that engine compartment is well-ventilated and that there are no gasoline vapors present (during the test) to prevent the possibility of an explosion and/or a fire, should a spark occur.

1. Disconnect negative (–) battery cable from battery.
2. Disconnect orange lead from alternator output terminal and connect ammeter in series between lead and output terminal. Connect positive (+) side of ammeter toward output terminal.
3. Reconnect negative battery cable.
4. Remove coil high-tension lead from distributor cap tower and ground it to block. Turn on all accessories and crank engine over with starter motor for 15-20 seconds.

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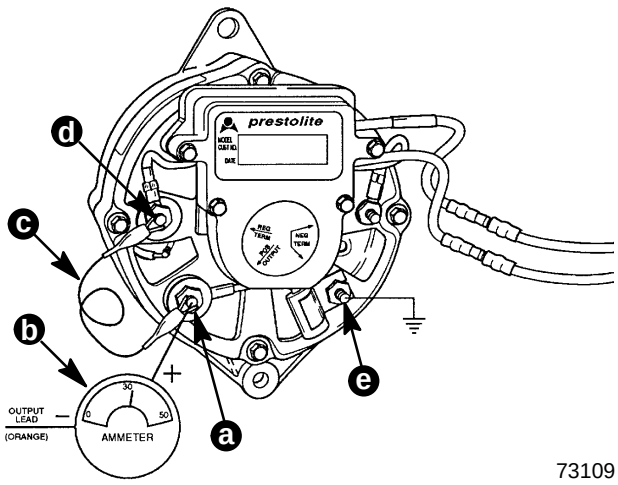
5. Turn off accessories and reinstall coil hi-tension lead. Start engine and adjust engine speed to 1500-2000 RPM. Quickly observe ammeter. Reading should be at least 30 amps.
6. If reading is low, stop engine and connect a jumper wire between alternator output terminal and regulator terminal. Repeat Steps 4 and 5.
7. If reading is now within specifications, diodes are faulty. Disassemble alternator and replace rectifier as explained under “Alternator Repair,” following, to determine if fault is in regulator or alternator.
8. If reading is still low with jumper wire connected, perform “Voltage Output Test,” following, to determine if fault is in regulator or alternator.



73109

a - Output Wire (ORANGE)
b - Ammeter (0-50 Amps.)
c - Jumper Lead
d - Regulator Terminal
e - Ground

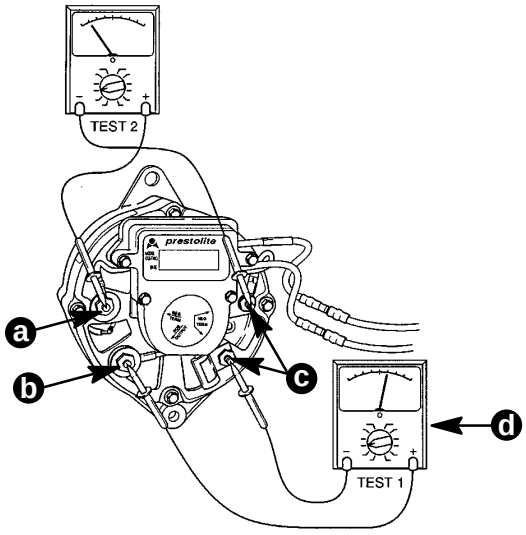
OPEN REGULATOR TEST

IMPORTANT: This test requires removal of regulator.

⚠CAUTION

To prevent electrical system damage and/or sparks, disconnect battery cables at battery.

1. Remove insulator cap from regulator terminal.
2. With ignition switch on and engine not running, check for battery voltage at alternator output terminal (Test 1) and regulator terminal (Test 2).

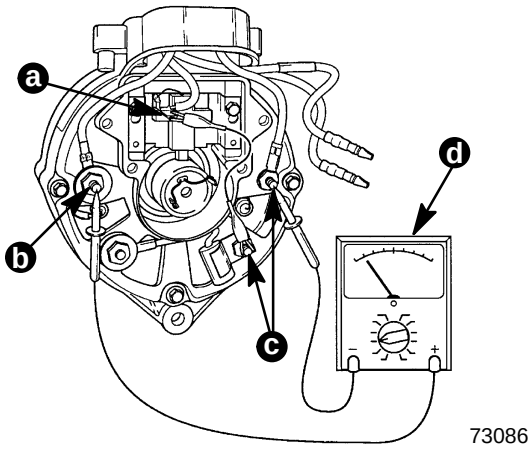


73083

a - Regualtor Terminal
b - Output Terminal
c - Ground
d - Voltmeter (0-20 Volts)

3. Remove the four screws which secure the regulator to the alternator.

4. Connect a jumper wire between field terminal (green wire) and ground. If 1.5 to 3.0 volts are present at regulator terminal, regulator is defective. If voltage is not present at regulator terminal, there is an open field circuit (brushes slip rings, etc.). Remove alternator for repair.



a - Field Terminal (GREEN Wire)
b - Regulator Terminal
c - Ground
d - Voltmeter (0-20 Volts)

NOTE: *Felt gasket is shown removed for visual clarity.*

Alternator Repair

⚠WARNING

Be sure that engine compartment is well-ventilated and that there are no gasoline vapors present to prevent the possibility of an explosion and/or a fire, should a spark occur.

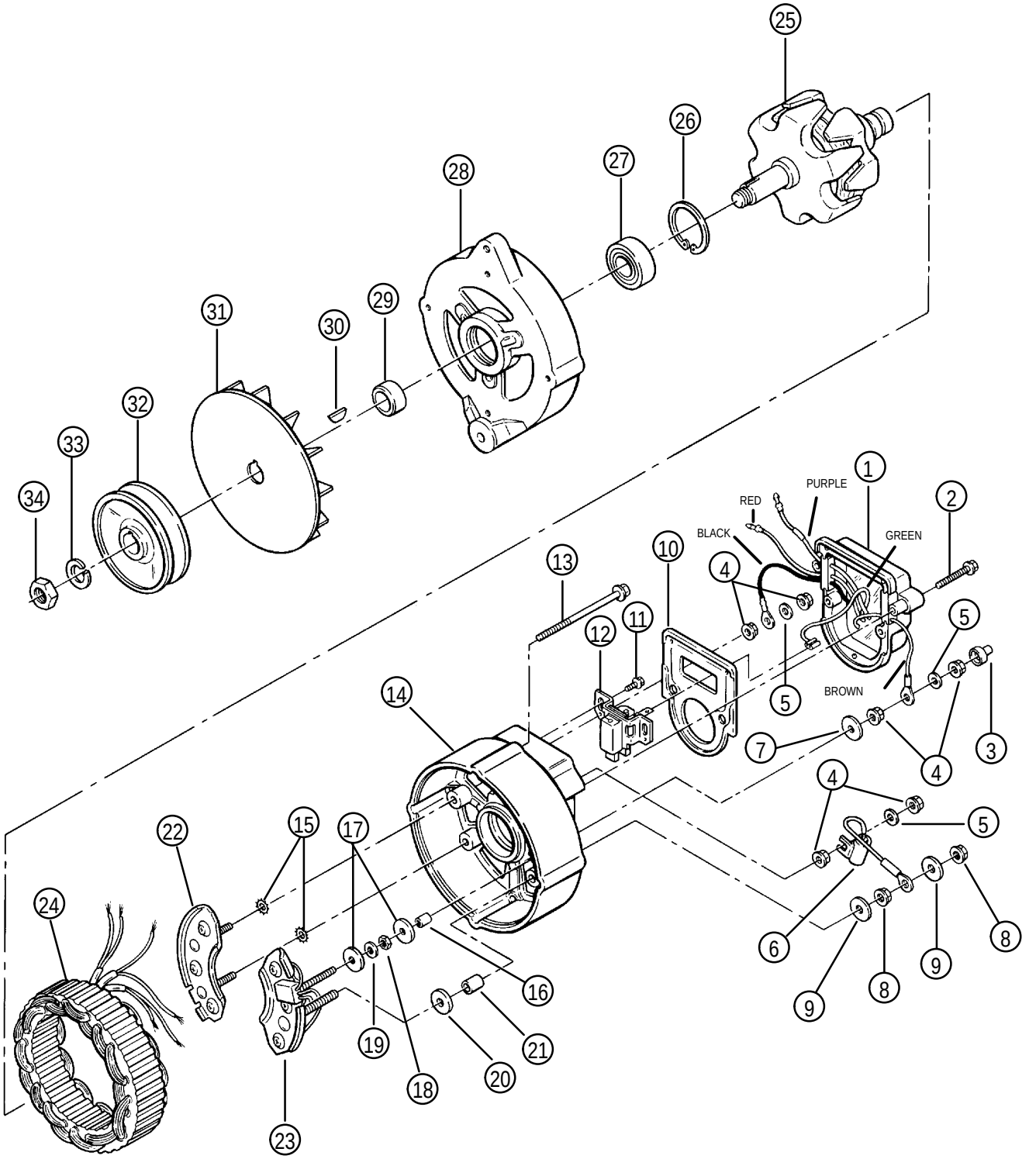
Removal

⚠CAUTION

To prevent electrical system damage and/or sparks, disconnect battery cables at battery.

1. Disconnect battery cables from battery.
2. Disconnect wiring harness from alternator.
3. Remove alternator belt.
4. Remove alternator.

Exploded View

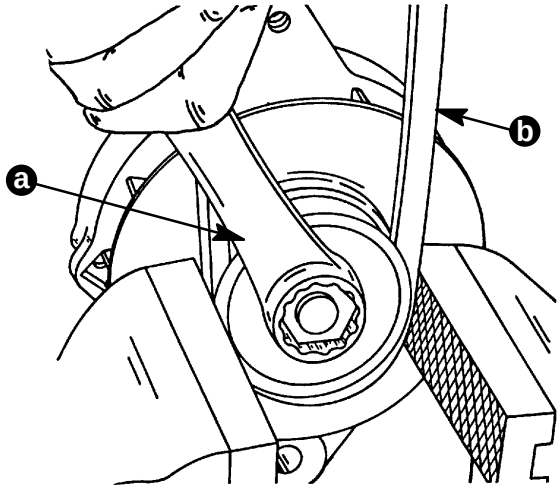


73106

1 - Regulator And Leads
2 - Screws (4)
3 - Insulator Cap
4 - Nuts (6)
5 - Washers (3)
6 - Condenser
7 - Insulator Washer (2)
8 - Nuts (2)
9 - Isualting Washer (2)
10 - Felt Gasket
11 - Screws (2)
12 - Brush Assembly
13 - Screws (4)
14 - Rear End Frame
15 - Star Washers (2)
16 - Insulator
17 - Insulating Washer (2)
18 - Nut
19 - Washer
20 - Insulating Washer
21 - Insulator
22 - Negative Rectifier
23 - Positive Rectifier / Diode Trio
24 - Stator
25 - Rotor and Slip Rings
26 - Snap Ring
27 - Bearing
28 - Front End Frame
29 - Fan Bushing
30 - Woodruff key
31 - Fan
32 - Pulley
33 - Lockwasher
34 - Nut

Disassembly

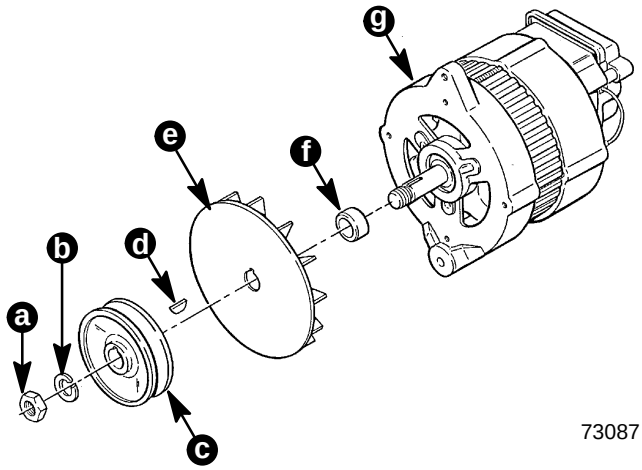
1. Using an oversized V-belt to protect the pulley, clamp alternator in vise as shown. Remove pulley nut and lockwasher.



72828

a - Wrench
b - Oversized V-Belt To Protect Pulley

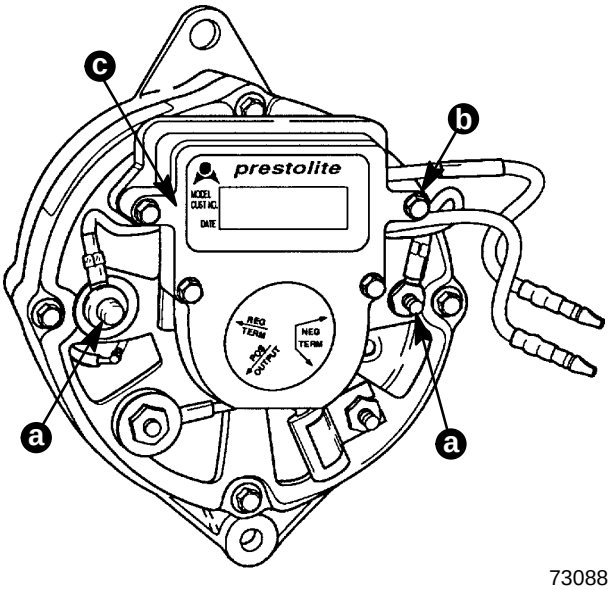
2. Remove pulley, fan, woodruff key and spacer.



73087

a - Nut
b - Lockwasher
c - Pulley
d - Woodruff Key
e - Fan
f - Spacer
g - Alternator

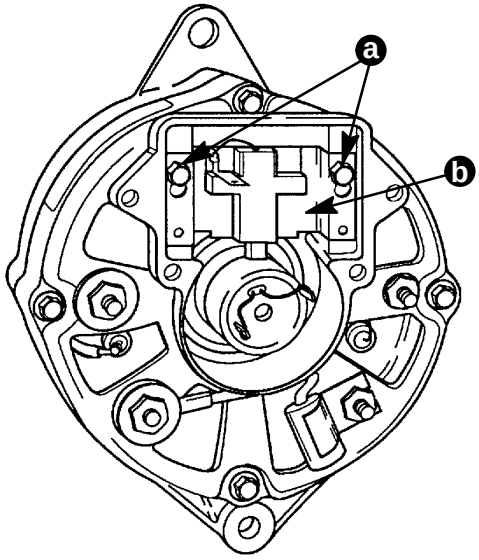
3. Disconnect regulator leads from terminals on rear end frame. Remove four regulator attaching screws, then pull regulator away from rear end frame and disconnect field lead.



73088

a - Regulator Leads (2)
b - Screws (4)
c - Regulator

4. Remove brush holder.



73090

a - Attaching Screws
b - Brush Holder

5. Note location of remaining insulating washers and nuts and remove.

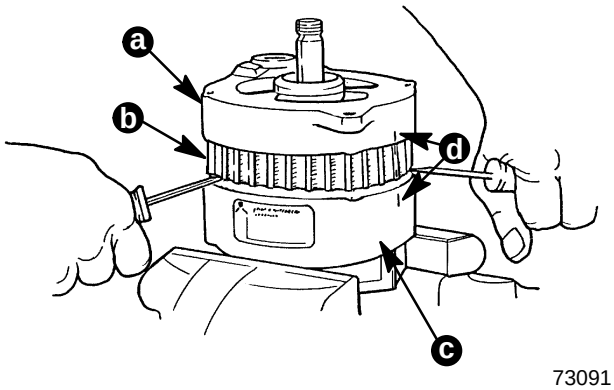
6. Scribe a mark on rear end frame, stator and front end frame to ensure proper reassembly later.

7. Remove the four screws which secure end frames and stator together.

⚠CAUTION

Do not insert screwdriver blades deeper than 1/16 in. (1.58 mm) to avoid damaging stator windings.

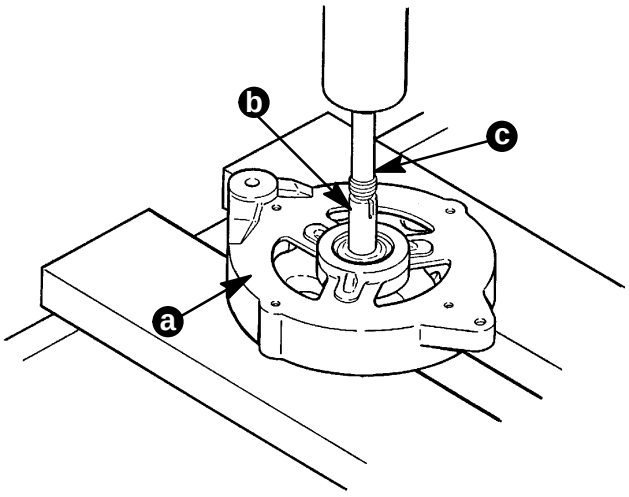
8. Using a suitable holding fixture, separate front end frame and stator assembly from rear end frame using two thin blade screwdrivers (positioned 180 degrees apart from each other) at the locations shown.



73091

a - Front End Frame
b - Stator
c - Rear End Frame
d - Scribe Marks

9. While supporting front housing, use an arbor press to remove rotor from front end frame.



73092

a - Front Housing
b - Rotor Shaft
c - Bearing Driver

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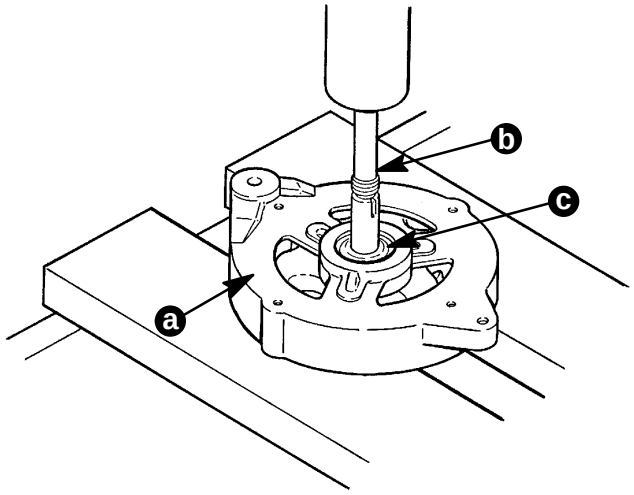
Cleaning and Inspection

1. Clean all parts with a clean, soft cloth. Do not use solvent, or electrical components may be damaged.
2. Inspect the following:
   a. **Brush Set** - Inspect for cracked porcelain casing, damaged brush leads, poor brush springs or worn brushes. Replace brush set if brushes are less than 3/16 in (5 mm) long.
   b. **Rotor** - Inspect for stripped threads, scuffed pole piece fingers or damaged bearing surfaces (because of bearing turning on shaft).
   c. **Rotor Slip Rings** - Clean slip rings with 400 grain (or finer) polishing cloth. Blow off dust with compressed air. Inspect slip rings for grooves, pits, flat spots or out-of-round [.002 in. (.05 mm) maximum]. Replace if defective.
   d. **Rotor Shaft Bearings** - Inspect for damaged seals, lack of lubrication, discoloration (from overheating) or excessive side or end play. Hold inner race of bearings while turning outer race. Bearing should turn freely without binding or evidence of rough spots.
   e. **Stator** - Inspect for damaged insulation or wires; also inspect insulating enamel for heat discoloration, as this is usually a sign of a shorted or grounded winding or a shorted diode.
   f. **Regulator** - Inspect leads for damaged insulation.
   g. **Front and Rear Housings** - Inspect for cracks, distortion, stripped threads or wear in bearing bore (from bearing outer race spinning in bore). Replace if defective.
   h. **Fan** - Inspect for cracked or bent fins, broken welds or worn mounting hole (from fan spinning on shaft).
   i. **Pulley** - Inspect pulley mounting bore and for wear. Inspect drive surface of pulley sheaves for trueness, excessive wear, or corrosion. Repair damaged surfaces, if possible, with a fine file and a wire brush, or replace pulley. Drive surfaces must be true and smooth, or drive belt wear will be greatly accelerated.
   j. **Alternator** - If alternator has output at low speeds, but no output at high speeds, rotor field winding may be shorting or grounding out because of centrifugal force. Replace rotor, if all other electrical components test good.

Front Bearing

Removal

1. Remove snap ring.
2. Use an arbor press to remove bearing from housing.

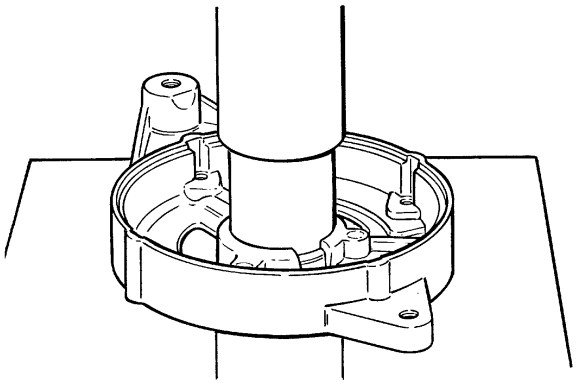


73093

a - Front Housing
b - Bearing Driver
c - Bearing

Installation

1. Using an arbor press, press on outer race of new bearing until fully seated in housing.



73094

2. Install snap ring to retain bearing.

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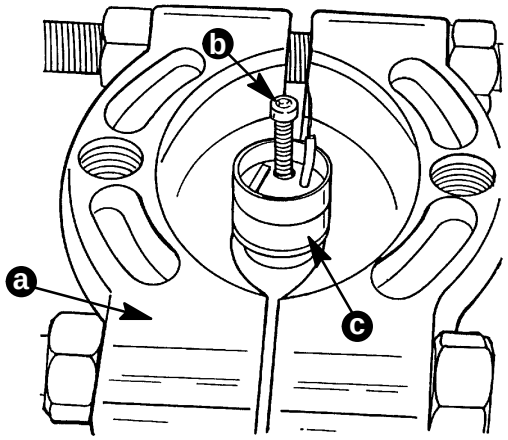
Slip Rings/Rear Bearing

Removal

1. Unsolder wires and carefully unwind them from slip ring terminals.

IMPORTANT: Do not damage rotor wires when removing slip rings or bearing.

2. Install a universal puller plate between bearing and slip rings. Insert a 10 x 1 in. capscrew into opening of slip ring assembly.



73095

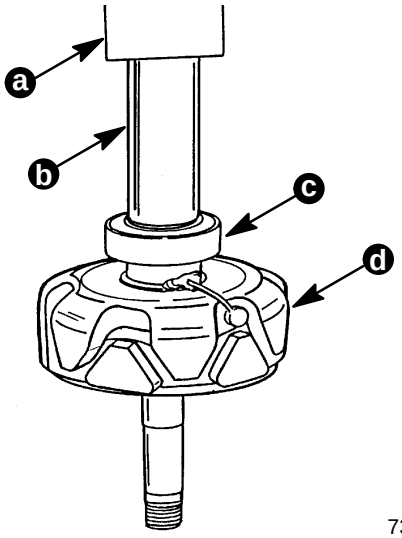
a - Univeral Plate Puller
b - Capscrew
c - Slip Rings

3. Using an arbor press, push against capscrew to remove slip rings.
4. Install a universal puller plate under bearing.
5. Using an arbor press, remove bearing.

Installation

1. Press new rear bearing all the way onto rotor shaft (until inner race contacts shoulder) with an arbor press and a bearing driver that contacts inner bearing race only, as shown. Use extreme care to prevent damage to field winding leads.

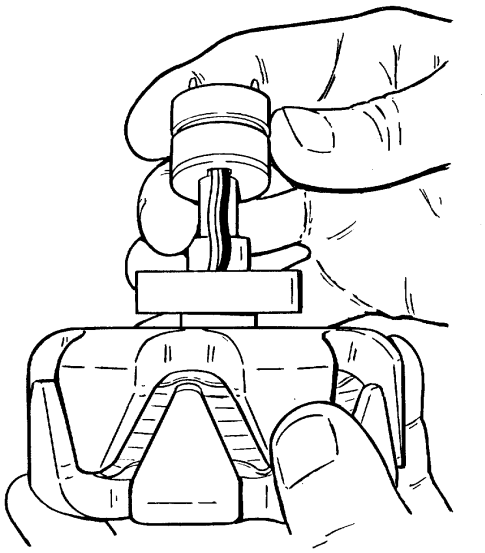
IMPORTANT: Be sure to support rotor on end of shaft and not on pole pieces, as pole pieces are only press-fit onto shaft.



73096

a - Arbor Press
b - Bearing Driver
c - Bearing
d - Rotor

2. Insert wires through hole in slip rings as shown.



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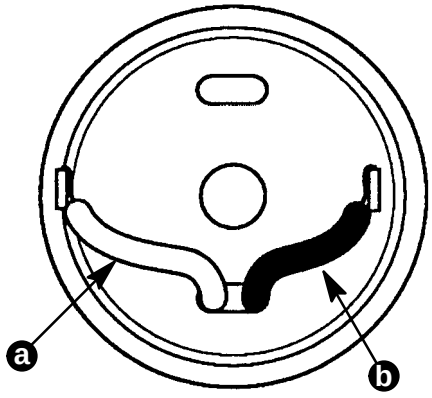
IMPORTANT: Press on the center of slip rings only. Do not bend terminals or pinch wires.

3. Using an arbor press, install slip rings. Press on center of slip rings until they contact shoulder of rotor.
4. Carefully wrap white wire around outer slip ring terminal, and blue wire around inner slip ring terminal. Solder wires in place.



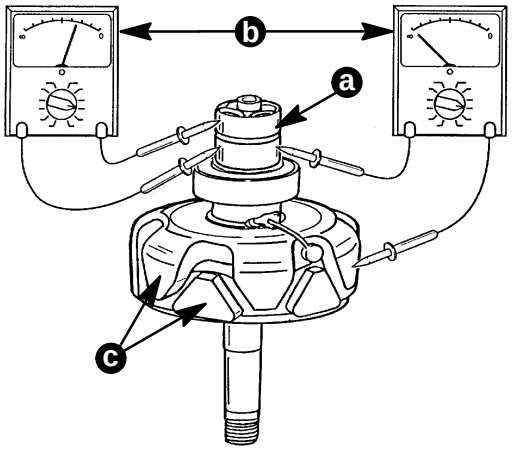
73098

a - WHITE Wire
b - BLUE Wire

Component Testing

Rotor

1. Test rotor field circuit for grounds, using an ohmmeter (set on Rx1 scale) as follows:
   a. Connect one lead of ohmmeter to either slip ring and the other lead to rotor shaft or pole pieces.
   b. Meter should indicate no continuity (meter should not move).
   c. If continuity does exist, rotor field circuit is grounded. Inspect slip ring terminals to be sure that they are not bent and touching rotor shaft. Also be sure that excess solder is not grounding terminals to rotor shaft. If cause for ground cannot be found, unsolder field winding leads from slip ring terminals and connect ohmmeter between one of the leads and rotor shaft or pole pieces. If continuity still exists, replace rotor assembly. If continuity is eliminated, replace slip rings.



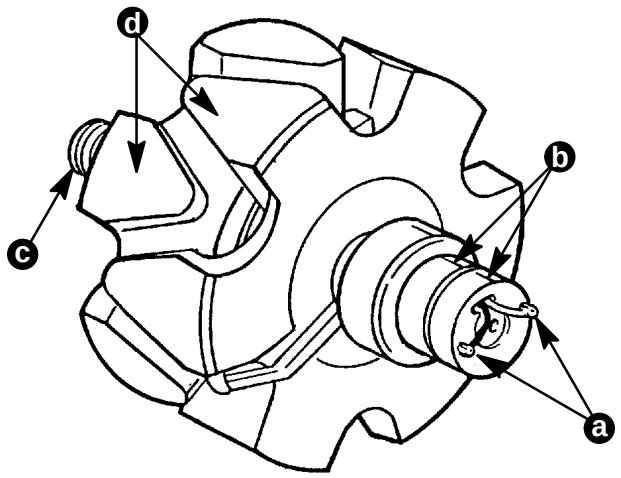
73099

a - Slip Rings
b - Ohmmeter With Leads
c - Pole Pieces

2. Test rotor field circuit for opens, shorts or high resistance, using an ohmmeter (set on Rx1 scale) as follows:
   a. Connect one ohmmeter lead to each slip ring.
   b. Ohmmeter reading should be 4.1 to 4.7 ohms with rotor at room temperature [70-80°F (21-26°C)].

c. If reading is high or infinite (no meter movement), high resistance or an open exists in the field circuit. Check for poor connections between field winding leads and slip ring terminals. If cause for open or high resistance cannot be found, connect ohmmeter directly to slip ring terminals. If correct reading is now obtained, replace slip rings. If reading is still high or infinite, replace complete rotor assembly.

d. If reading is low, a short exists in the field circuit. Inspect slip rings to be sure that they are not bent and touching outer slip ring. Also be sure that excess solder is not shorting terminals to aft slip ring. If cause for short cannot be found, unsolder field winding leads from slip ring terminals and connect ohmmeter directly to leads. If correct reading is now obtained, slip rings are shorted and must be replaced. If reading is still low, rotor field windings are shorted, and complete rotor assembly must be replaced.



73112

a - Field Winding Leads
b - Slip Rings
c - Rotor Shaft
d - Pole Pieces

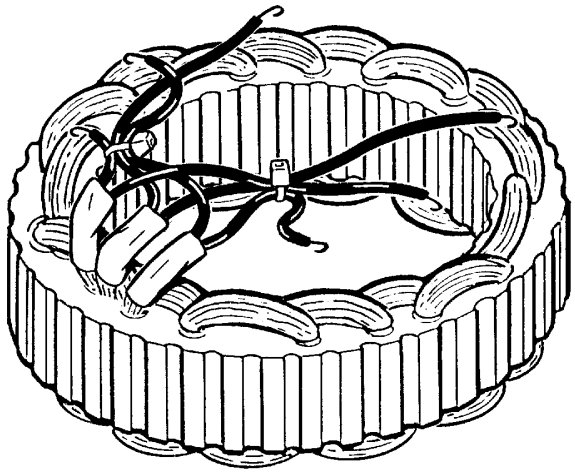
Stator

IMPORTANT: Stator leads MUST BE disconnected from rectifiers and diode-trio for this test.

⚠CAUTION

Excessive heat from de-soldering may cause damage to rectifiers or diode-trio assembly when disconnecting leads.

1. Test stator for grounds, using an ohmmeter (set on Rx1 scale) as follows:
   a. Connect one lead of ohmmeter or test lamp to one of the stator leads and the other lead to stator frame. Be sure that lead makes good contact with frame.
   b. Meter should indicate no continuity (meter should not move). If continuity does exist, stator is grounded and must be replaced.



73101

NOTE: *It is necessary to test only three of the six leads on EITHER side of the stator as the leads are interconnected in the windings.*

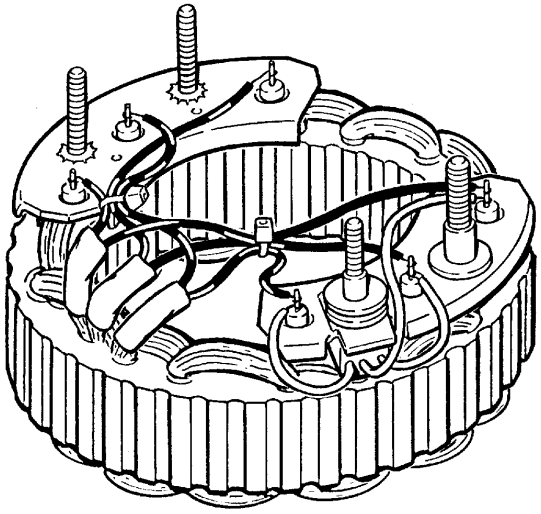
2. Test for opens in stator, using an ohmmeter (set on Rx1 scale) as follows:
   a. Connect ohmmeter or test lamp between each pair of stator windings (3 different ways).
   b. Continuity should be present in all three cases (meter should move). If it does not, one or more of the windings are open and stator must be replaced.

Index

3. A short in the stator is difficult to detect without special equipment, because of the low windings resistance. If all other electrical components test out good, and alternator fails to produce rated output, stator probably is shorted and should be replaced. Also, examine stator for heat discoloration, as this usually is a sign of a short.

Positive/Negative Rectifier and Diode-Trio Assembly

IDENTIFICATION



73100

NEGATIVE (–) RECTIFIER

⚠CAUTION

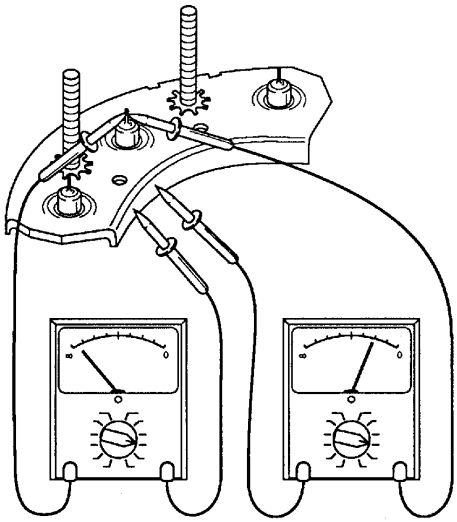
Do not use a test instrument with more than a 12-volt source in the following test, as rectifier may be damaged.

IMPORTANT: Rectifier MUST BE disconnected from stator for this test.

⚠CAUTION

Excessive heat from de-soldering may cause damage to rectifier when disconnecting leads.

1. Identify the leads prior to removal so they can be reassembled to their original positions.
2. Using an ohmmeter (set on Rx1 scale), check for continuity between rectifier terminal and heat sink. Reverse ohmmeter leads and recheck. Continuity should be observed in one direction (polarity) only.
3. Check other two rectifiers in same manner.
4. Replace assembly if any of the rectifiers is shorted or open.



73102

POSITIVE (+) RECTIFIER AND DIODE-TRIO

⚠CAUTION

Do not use a test instrument with more than a 12-volt source in the following test, as rectifier may be damaged.

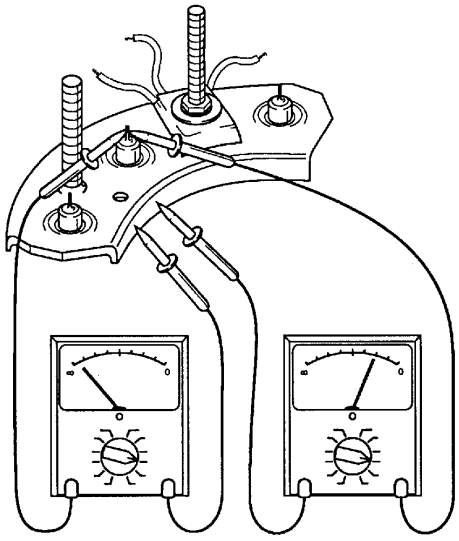
IMPORTANT: Rectifier MUST BE disconnected from stator for this test.

⚠CAUTION

Excessive heat from de-soldering may cause damage to rectifier or diode-trio assembly when disconnecting leads.

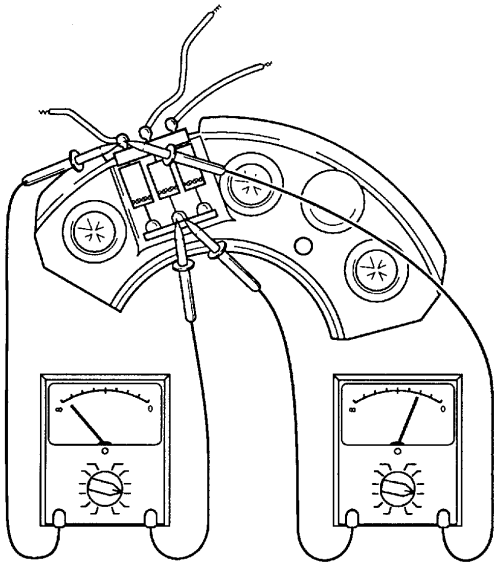
1. Identify the leads prior to removal so they can be reassembled to their original positions.
2. Using an ohmmeter (set on Rx1 scale), check for continuity between rectifier terminal and heat sink. Reverse ohmmeter leads and recheck. Continuity should be observed in one direction (polarity) only.

3. Check other two rectifiers in same manner.
4. Replace assembly if any of the rectifiers is shorted or open.



73103

5. Using an ohmmeter (set on Rx1 scale), check for continuity between the common side of the diodes and one of the terminals on other side of the diode. Reverse ohmmeter leads and recheck. Continuity should be observed in one direction (polarity) only.
6. Check other two diodes in same manner.
7. Replace diode-trio if any of the diodes is shorted or open.



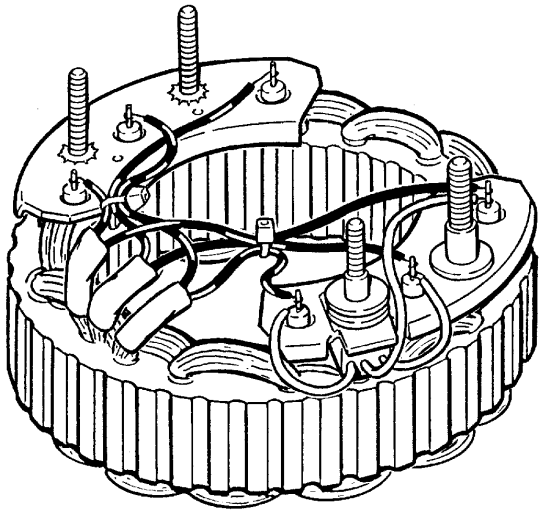
73104

Condenser

1. Using Magneto Analyzer (P/N 91-76032) and accompanying instructions, perform the following condenser tests:
   a. Condenser Capacity Test (must be .5 mfd)
   b. Condenser Short or Leakage Test
   c. Condenser Series Resistance Test
2. Replace condenser if test results are not within specifications.

Reassembly

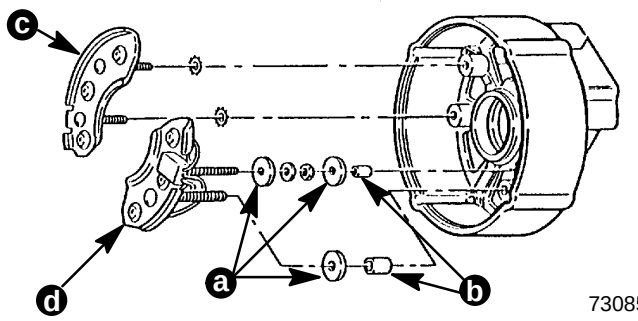
1. Solder positive/negative rectifier and diode-trio assembly to stator. Connect leads to original location as identified during disassembly.



73100

2. Install rotor to front end frame.

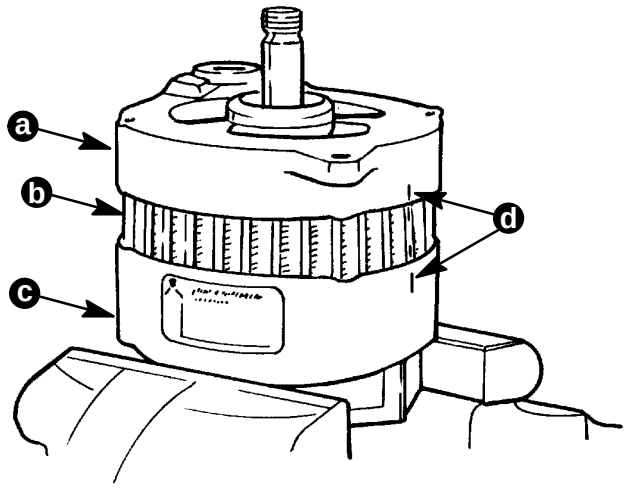
IMPORTANT: The insulators MUST BE installed as shown or damage to the alternator will result.



73085

a - Insulating Washers
b - Insulators
c - Negative Rectifier
d - Positive Rectifier / Diode Trio

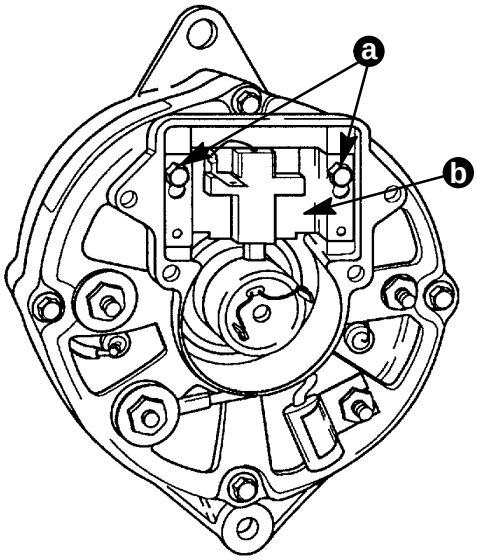
3. Position rear end frame and stator assembly with insulators over front end frame and rotor assembly. Align scribe marks on each (scribed during disassembly). Hand press end frames together, then install four screws. Torque screws to 50-60 lb. in. (5.6-6.7 N·m).



73105

a - Front End Frame
b - Stator
c - Rear End Frame
d - Scribe Marks

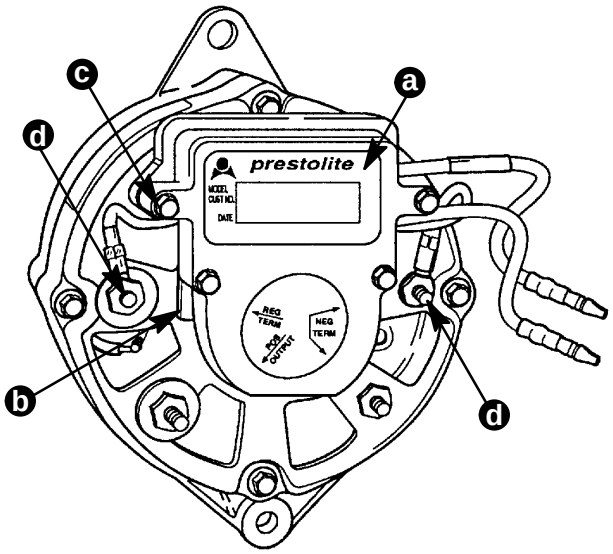
4. Install brush holder into rear end frame and slide forward to depress brushes against slip ring. Insert two screws and tighten securely.



73090

a - Attaching Screws
b - Brush Holder

5. Attach field lead to brush assembly. Install regulator and felt gasket to rear end frame. Install four screws and tighten securely. Reconnect regulator terminal leads to appropriate stud on rear end frame.



73107

a - Regulator
b - Felt Gasket
c - Screws(4)
d - Regulator Leads

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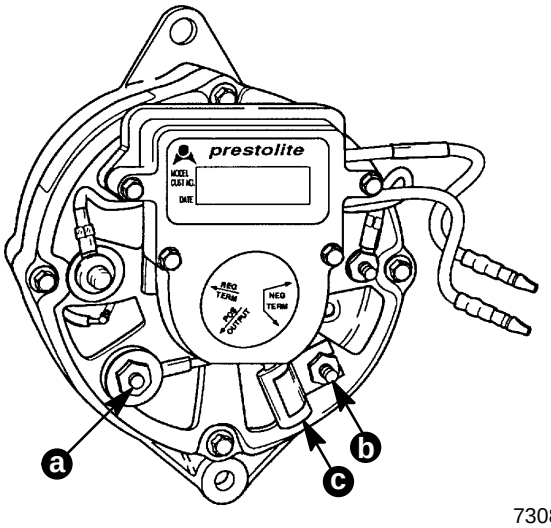
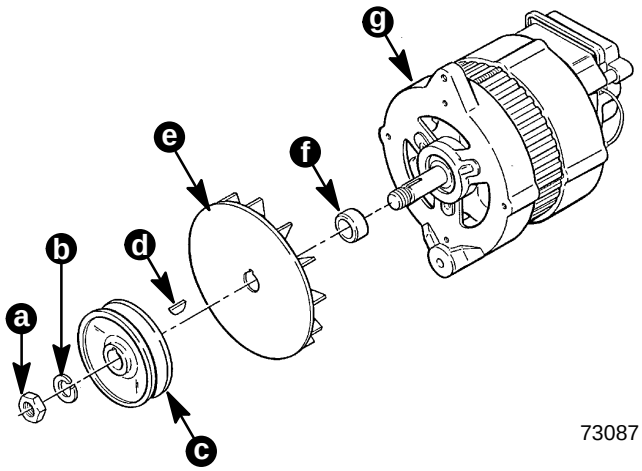
6. Place condenser on ground terminal and lead on output terminal. Install insulator cap on regulator terminal.



73088

a - Output Terminal
b - Ground Terminal
c - Condenser

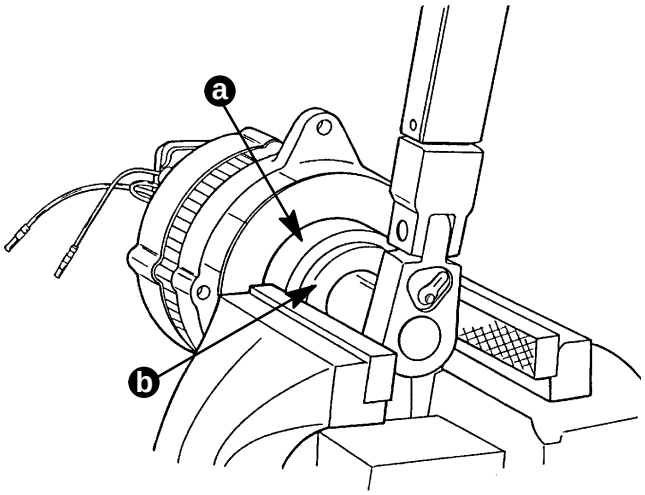
7. Install spacer, woodruff key, fan, pulley, lockwasher and nut.



73087

a - Nut
b - Lockwasher
c - Pulley
d - Woodruff Key
e - Fan
f - Spacer
g - Alternator

8. Using an oversized belt to protect the pulley, clamp alternator in vise as shown. Tighten pulley nut to 35-50 lb. ft. (48-68 N·m).



73108

a - Oversized Belt
b - Pulley

Installation

1. Install alternator on engine.
2. Install alternator belt and adjust as outlined under “Drive Belt Tension Adjustment.”
3. Tighten mounting bolts to specifications.
4. Reconnect wiring harness to alternator and negative battery cable to battery.
5. Coat all terminal lead connections with Quicksilver Liquid Neoprene.

Battery Isolators

Dual Battery Charging Systems Using a Battery Isolator

Battery isolators allow the addition of an auxiliary (second) battery to the MerCruiser electrical system. The auxiliary battery is primarily used as a power source for various accessories installed on the boat. The battery isolator will allow the alternator to charge both the cranking and auxiliary batteries at the same time while preventing accessories, connected to the auxiliary battery, from drawing power from the cranking battery.

Mercury Marine does not manufacture any battery isolator systems. Battery isolators must be bought from an outside manufacturer. Mercury Marine suggests following the manufacturer's instructions carefully.

IMPORTANT: Alternators used on MerCruiser engines ARE NOT equipped with an isolation diode.

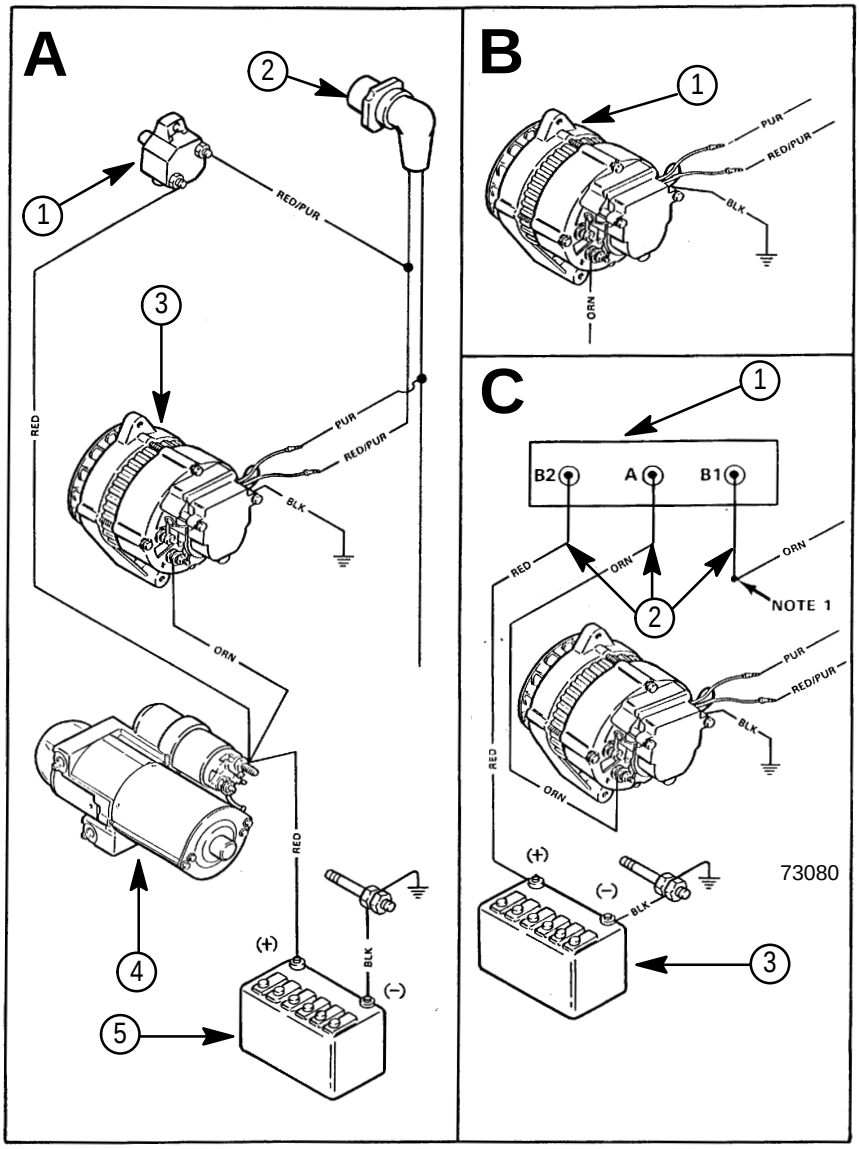
⚠ CAUTION

Follow battery isolator manufacturer's instructions for wire gauge. Battery isolator installation must conform to BIA Low Voltage Wiring Standard No. 125-79.

NOTE: *MerCruiser engines equipped with a 3-wire, belt driven alternator, can use a battery isolator.*

Battery Isolator

BLK = BLACK
BLU = BLUE
BRN = BROWN
GRY = GRAY
GRN = GREEN
ORN = ORANGE
PNK = PINK
PUR = PURPLE
RED = RED
TAN = TAN
WHT = WHITE
YEL = YELLOW
LIT = LIGHT
DRK = DARK



Alternator with Voltmeter Circuit (Typical Wiring Shown)

Note :Disconnect ORANGE wire from alternator "Batt" terminal. Splice sufficient length of proper gauge wire and connect as shown.

A - Wiring Diagram

1 - Ciruit Breaker
2 - Wiring Harness
3 - Alternator
4 - Starter
5 - Cranking Battery

B - Original Wiring

1 - Alternator

C - Wiring Connections With Isolator

1 - Isolator
2 - Use 8 Gauge Wire Minimum
3 - Auxiliary Battery

Index

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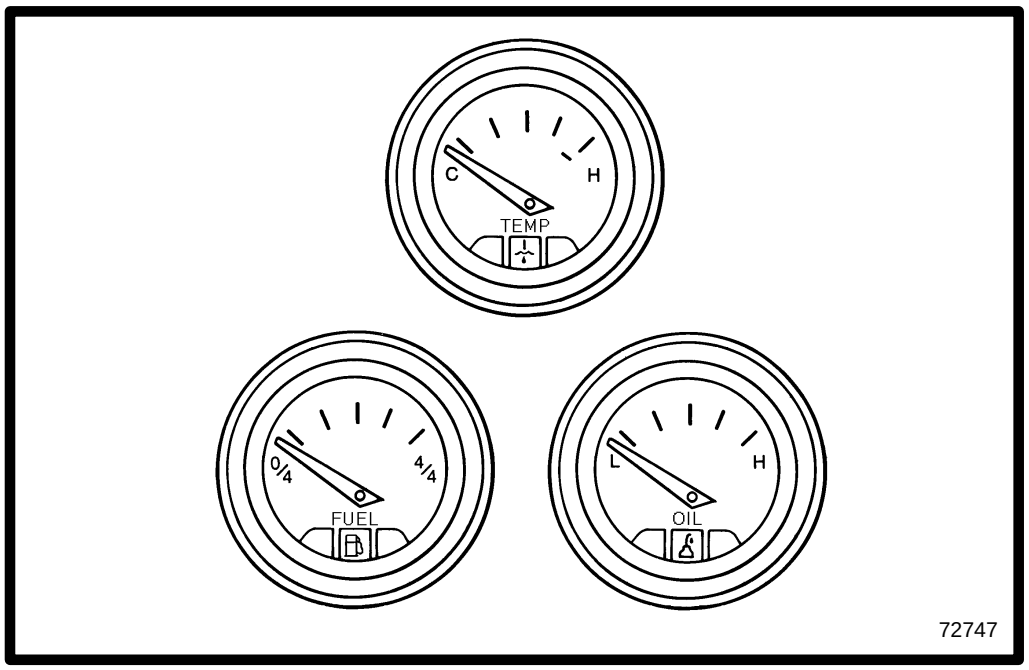
ELECTRICAL SYSTEM

4

D



INSTRUMENTATION

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NOTICE

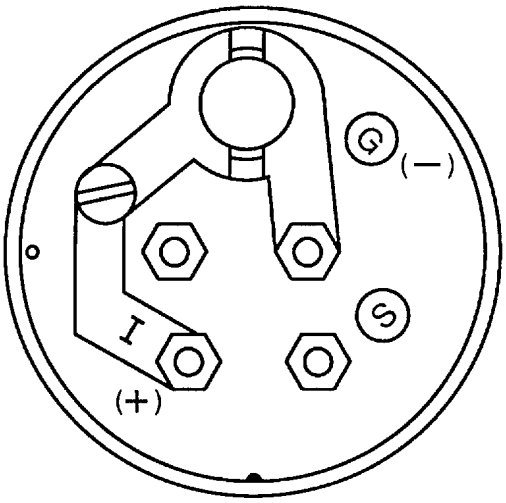
For information and procedures on trouble-shooting, refer to Section 1C.

NOTICE

For information and procedures on Fuel Injection Engines, refer to Section 5C.

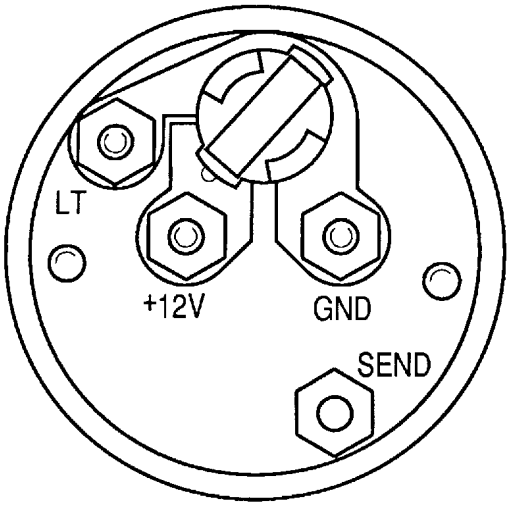
Identification

NOTE: *One of three distinct lines (Series) of Quicksilver gauges may be installed (if equipped with Quicksilver gauges). Aside from different gauge face appearances and styling, the back of the gauges and wiring connections are different as shown.*



72746

Back of Commodore and International Series Gauge - Typical



72965

Back of QSI Series Gauge - Typical

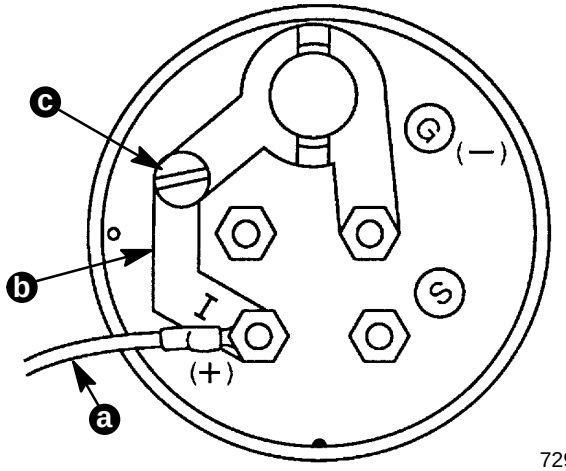
Special Information

Lighting Options

COMMODORE AND INTERNATIONAL SERIES

These gauges may be wired so that the illumination lighting is provided from the ignition switch or a separate instrumentation lighting switch.

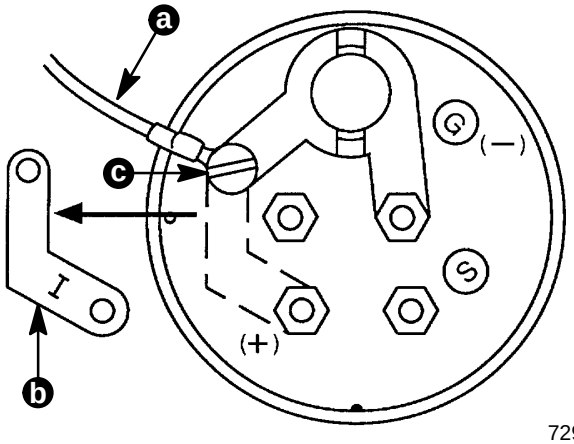
By removing contact strip “I” from between + terminal and the screw as shown following, and supplying a separate +12 V power supply to the screw connection, illumination lights can be operated independent of ignition switch.



72966

Ignition Switch Lighting Circuit

a - Positive (+) 12 Volt Power Supply From Ignition Switch
b - Contact Strip “I”
c - Screw Connection



72967

Separate Instrumentation Lighting Circuit Wiring

a - Positive (+) 12 Volt Power Supply From Ignition Switch
b - Contact Strip “I”
c - Screw Connection

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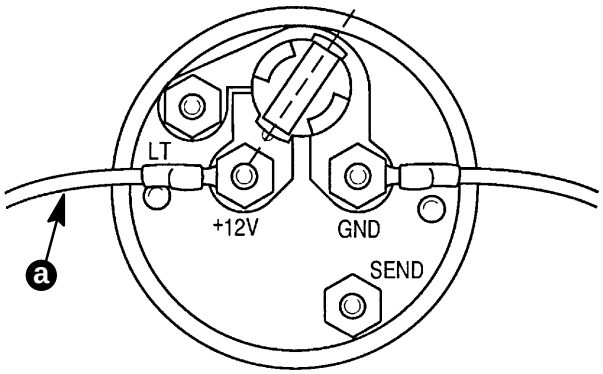
QSI SERIES

These gauges are equipped with optional illumination lighting. Light bulb socket can be removed and contacts can be aligned to be used with ignition switch lighting circuit +12 V or separate instrumentation lighting circuit LT.

IMPORTANT: Light socket must be removed from gauge and turned counterclockwise (facing back of gauge) when adjusting to desired setting. Turning socket while still installed in gauge could result in damage to gauge or socket.

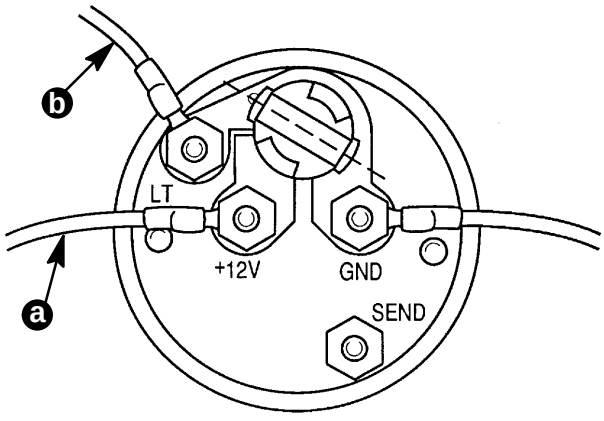
NOTE: *For different lighting effects, colored sleeves are available through the Quicksilver Accessories and can be assembled to the bulb.*



72968

Ignition Switch Lighting Circuit Position

a - Positive (+) 12 Volt Power Supply From Ignition Switch



72969

Separate Instrumentation Lighting Circuit Position

a - Positive (+) 12 Volt Power Supply From Ignition
b - Positive (+) 12 Volt Power Supply From Separate Instrumentation Lighting Circuit

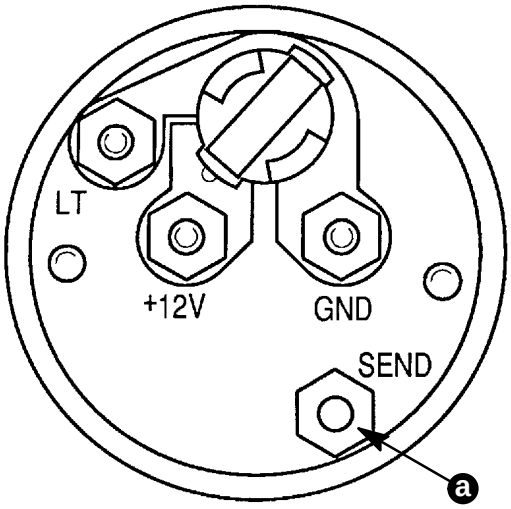
Gauges

Oil, Fuel and Temperature

IMPORTANT: If testing proves gauge to be defective, it must be replaced as there is no repair available.

TESTING

1. Turn ignition switch to OFF.
2. Remove wire from terminal S (SEND).

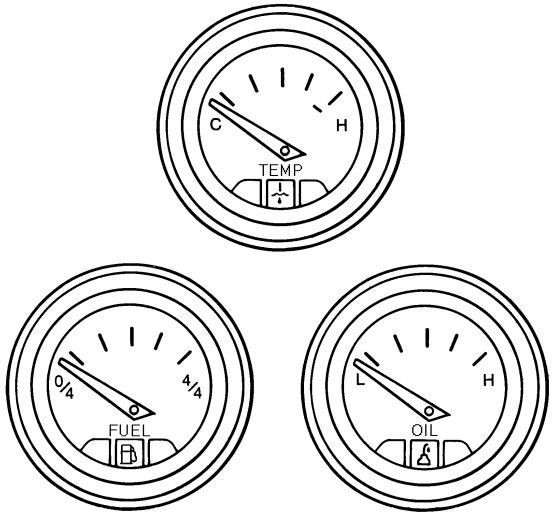


72965

Typical

a - Terminal S (SEND)

3. Turn ignition switch to RUN. Gauge being tested must be at position A.



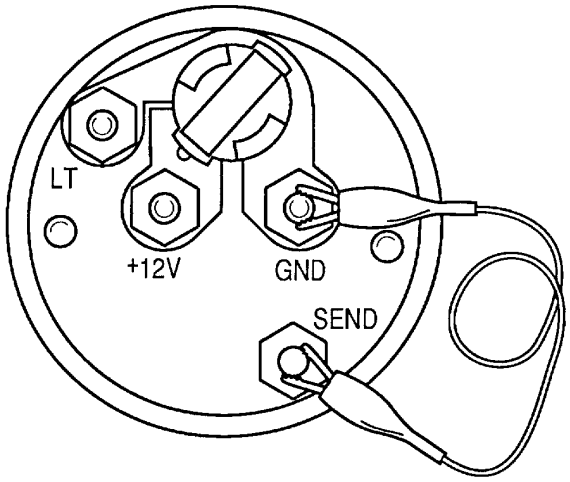
Position A

72747

Typical

4. Turn ignition switch to OFF.

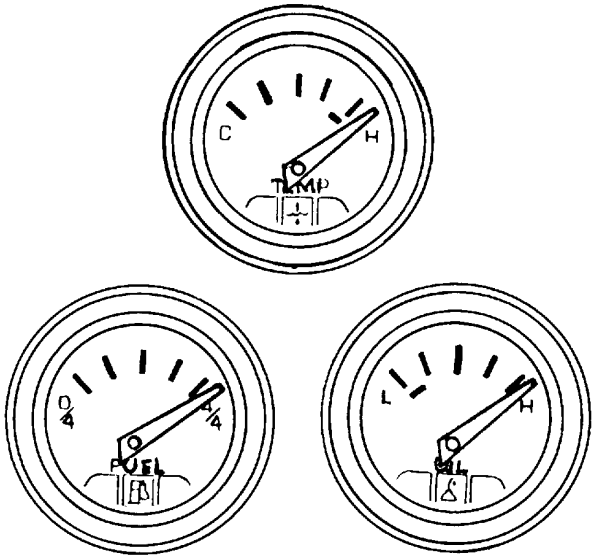
5. Connect jumper wire from terminal G (GND) to terminal S (SEND).



72748

Typical

6. Turn ignition switch to RUN.
7. Indicator needle of gauge being tested must read at position B. If not, replace gauge.



Position B

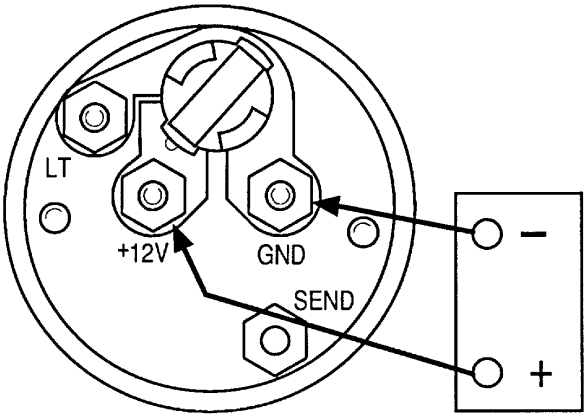
72749

Typical

Battery Gauge

TESTING

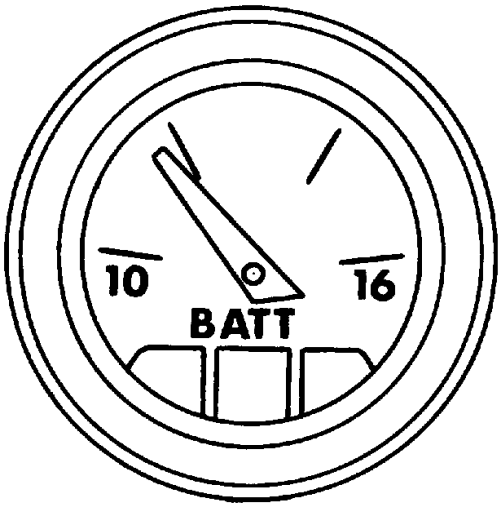
1. Remove cables from battery and fully charge battery.
2. Connect negative (–) jumper lead from battery to gauge terminal G (GND).
3. Connect positive (+) jumper lead from battery to gauge terminal I or +12 V.



72750

Typical

4. Check gauge reading; if not as shown replace gauge.



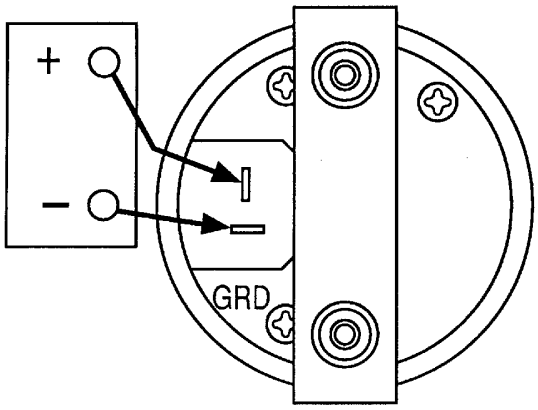
72751

Typical

Cruiselog Meter

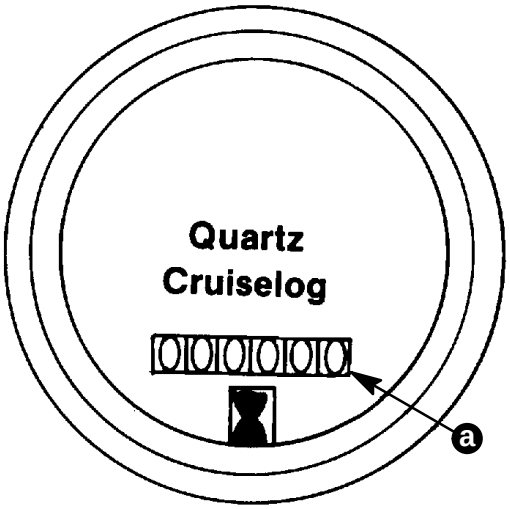
TESTING

1. Connect jumper wire from negative (–) battery terminal to negative (–) gauge terminal.
2. Connect jumper wire from positive (+) battery terminal to positive (+) gauge terminal.



72752

3. Observe gauge run indicator. If indicator is turning, gauge is operable; if not, replace gauge.



72753

a - Indicator

Vacuum Gauge

TESTING

1. Disconnect vacuum hose from engine. Connect service vacuum gauge to engine and record engine vacuum readings at idle, 1000, 2000 and 3000 RPM. Reconnect vacuum hose and compare vacuum gauge readings (at specified RPM) with service gauge readings. Readings should be within 3 inches of vacuum of each other.

IMPORTANT: Make sure that vacuum hose between gauge and engine is not leaking and that all connections are tight.

Speedometer

TESTING

IMPORTANT: When testing speedometer gauge for accuracy, the air supply used for the test must be regulated to the specified air pressure. Do not apply excessive air pressure to speedometer gauge.

1. Apply air pressure directly to speedometer gauge (specified in chart) and note gauge reading. Light tapping of pressure gauge is required during accuracy check.
2. If gauge readings are not within specifications, gauge is defective

CALIBRATION CHART

Air Pressure Guage PSI	Speedometer Gauge MPH (km/Hr)
5.3	20±2 (32±1.6)
27.8	45±1 (72±1.6)

Tachometer

TESTING

1. Connect a service tachometer to engine and compare readings.
2. Replace if not within specifications.

Tachometer	Allowance
6000 RPM	± 150 RPM
8000 RPM	± 200 RPM

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Gauge Replacement

1. Disconnect battery cables from battery.
2. Remove wires from back of gauge.
3. Remove hoses (vacuum, speedometer gauge).
4. Disconnect light socket.
5. Remove holding strap and remove gauge.
6. Position gauge assembly in appropriate mounting hole.
7. Install holding strap and nuts. Tighten nuts evenly and securely.

IMPORTANT: Do not distort case or bracket by over-tightening.

8. Connect ground (BLACK) wire to ground terminal, if gauge is not mounted in metal panel.
9. Connect other wires to gauge as shown in Section 4F.
10. Connect hoses (vacuum, speedometer gauges).
11. Install gauge light socket.
12. Coat all terminals with Quicksilver Liquid Neoprene.
13. Reconnect battery cables to battery.

Senders

Oil Pressure

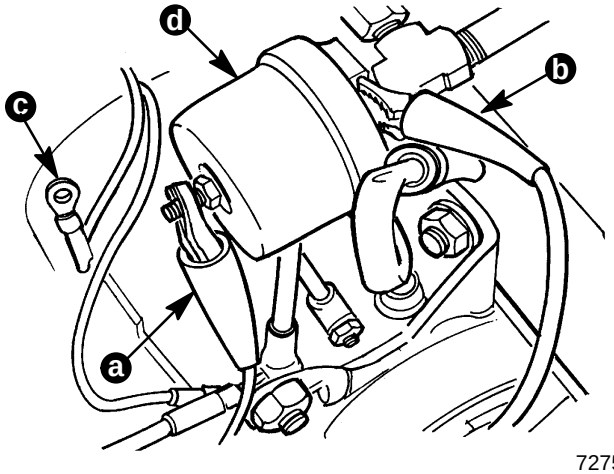
DUAL STATION SENDER IDENTIFICATION

Sender will have 353-AM stamped on hex of sender.

TESTING

IMPORTANT: Use following test procedure for checking accuracy of oil pressure sender only. If oil pressure gauge indicates zero oil pressure, refer to Section 1C - "Troubleshooting."

1. Remove wire from sender terminal.
2. Connect ohmmeter between sender terminal and sender case. Check ohms reading without engine running (zero pressure), then check reading with engine running. Compare oil pressure and ohms readings as shown in following chart:



72754

a - Positive Lead
b - Negative Lead
c - Wire Removed
d - Oil Pressure Sender

Oil Pressure (PSI)	Ohms Reading Single	Dual
0	227-257	113.5-128.5
20	142-162.5	71-81.25
40	91.7-113.6	45.8-56.8
80	9-49	4.5-24.5

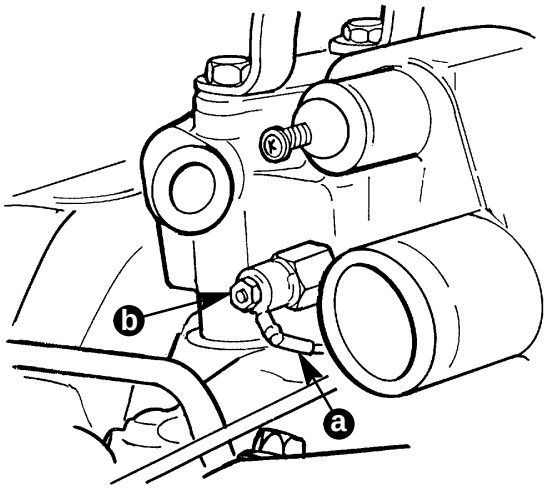
Water Temperature

DUAL STATION SENDER IDENTIFICATION

Sender will have 362-BC stamped on hex.

REMOVAL

1. Drain coolant from closed cooling system into a suitable container as outlined in Section 6B.
2. Remove TAN wire from temperature sender.



72611

Typical Water Temperature Sender

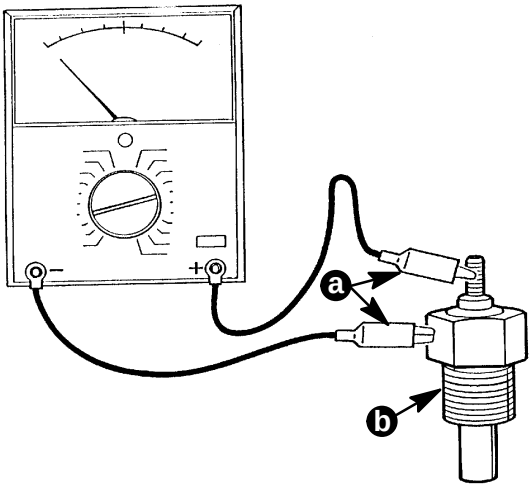
a - TAN Wire
b - Water Temperature Sender

NOTE: *Hoses are shown removed for clarity.*

3. Remove temperature sender.

TESTING

1. Connect an ohmmeter between temperature sender terminal (+) and hex (case) for ground (–) as shown.



72768

a - Ohmmeter Leads
b - Water Temperature Sender

⚠WARNING

The following test involves the use of intense heat. Failure to follow appropriate procedures or warnings can cause burns which can result in severe personal injury. While performing the following test, observe these general precautions:

- **Wear personal protective clothing such as rubber gloves, a non-flammable apron, and eye protection - preferably full face shield or safety glasses.**
- **The appropriate heat source should only be electric. Heat source should be operated by a qualified person. Be sure to follow all instructions of the manufacturer of the heat source. The heat source should be checked each time it is used to be sure it is functioning properly.**
- **The thermometer used in the test should be a high-temperature thermometer with a maximum reading of at least 300°F (150°C). Under no circumstances should the operator allow temperatures to exceed test specifications.**
- **Perform test only in a well ventilated area.**
- **Use a suitable container, such as metal, to hold the water. Avoid use of glass containers unless the operator first confirms for himself/herself that the glass container is an appropriate high-temperature vessel.**
- **Because the components will reach high temperatures DO NOT handle materials or components until COMPLETELY cooled.**

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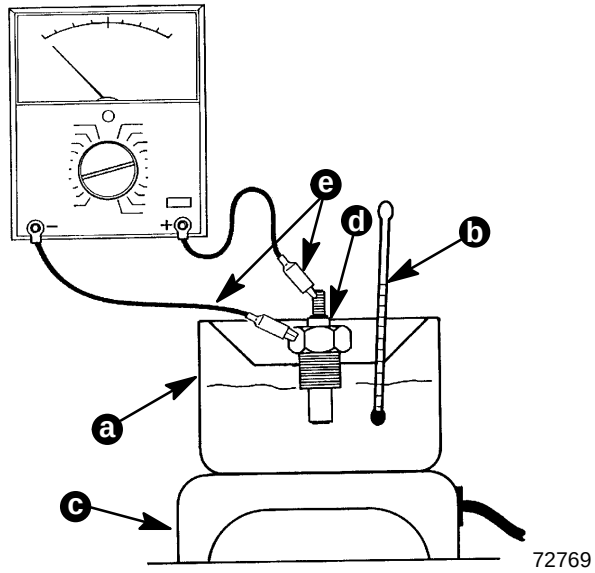
2. Follow these instructions:
   a. With ohmmeter connected as outlined and using suitable container, thermometer and heat source, suspend sender with tip in water.
   b. Heat water and observe thermometer.
   c. As temperature rises ohmmeter readings must be within the ranges specified for each temperature (see chart below).
   d. Turn heat source off. Allow water and components to cool.

NOTE: *While water cools you may recheck ohmmeter readings.*



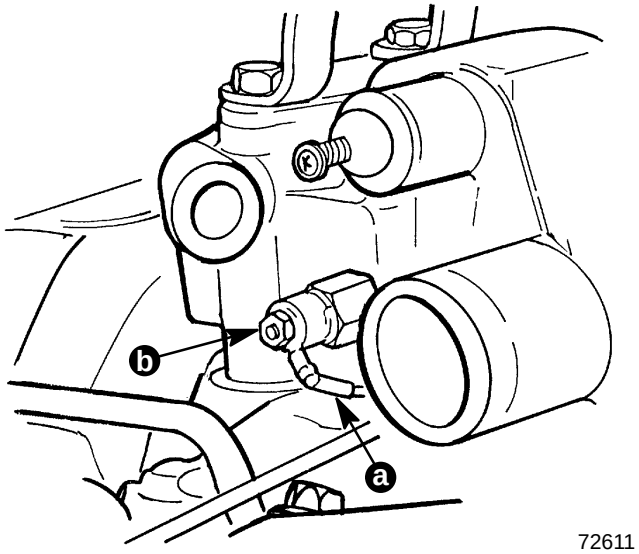
a - Suitable Container
b - Thermometer
c - Heat Source
d - Water Temperature
e - Ohmmeter Leads

Water Temperature	Ohms Reading
140° F (60° C)	121-147
194° F (90° C)	47-55
212° F (100° C)	36-41

3. Replace sender if ohmmeter readings are other than as shown for each temperature.

INSTALLATION

1. Apply Loctite Pipe Sealant with Teflon to threads of temperature sender.
2. Install sender in thermostat housing and tighten securely.
3. Connect tan wire and coat with Liquid Neoprene.



Typical Water Temperature Sender

a - TAN Wire
b - Water Temperature Sender

4. Refill closed cooling system with approved coolant as outlined in Section 6B.

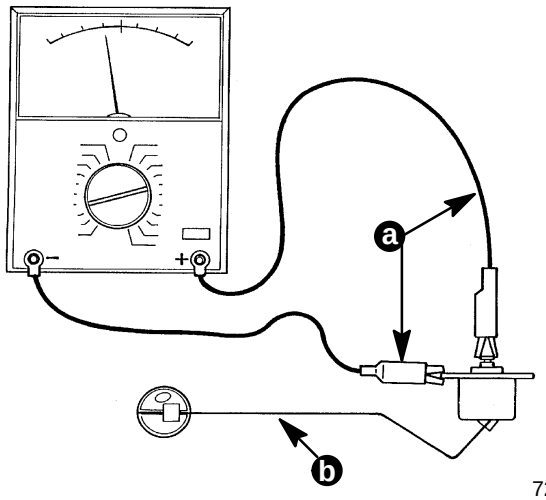
Fuel Tank Sender

FLANGE TYPE

Testing

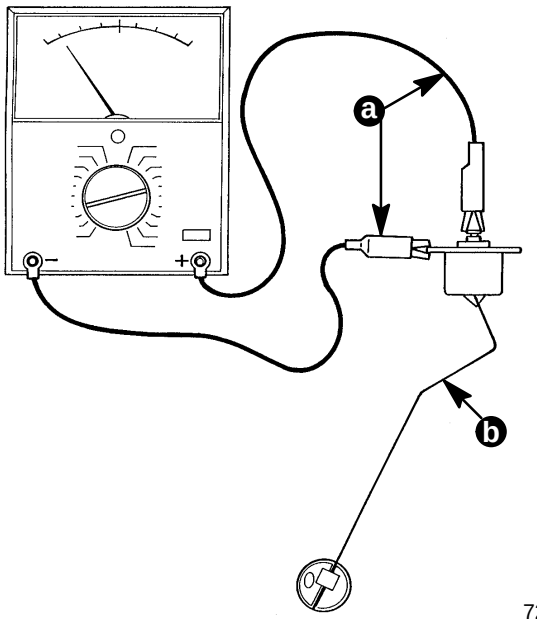
1. Disconnect wire from terminal on sending unit and ground wire from sending unit mounting screw.
2. Remove sending unit from fuel tank.
3. Connect ohmmeter between sending unit terminal and sending unit housing.

4. With float arm in FULL position (arm horizontal), ohmmeter should read 30 ohms (± 5 ohms).



a - Ohmmeter Leads
b - Vertical Float Arm

5. With float arm in EMPTY position (arm vertical) meter should read 240 ohms (± 5 ohms). Sender is defective if not within specifications.

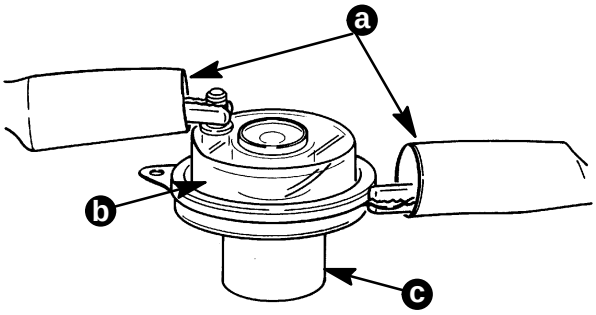


a - Ohmmeter Leads
b - Vertical Float Arm

CAPSULE TYPE

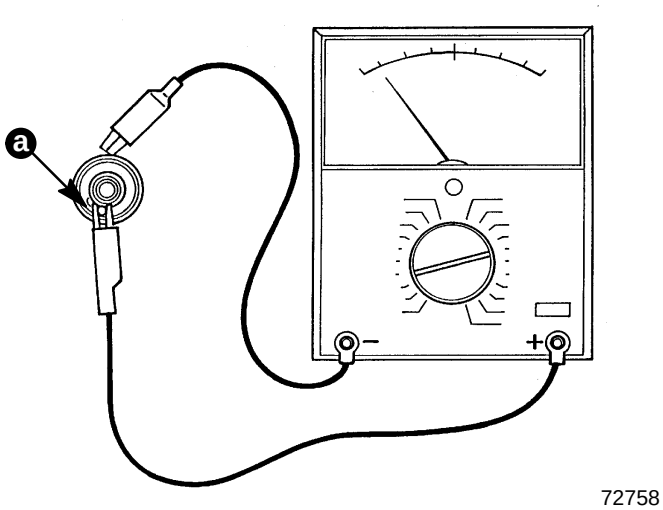
Testing

1. Disconnect wire from terminal on fuel tank capsule.
2. Remove two screws and remove capsule assembly.
3. Place a magnet under fuel capsule.
4. Connect ohmmeter between fuel capsule terminal and metal portion of capsule housing.



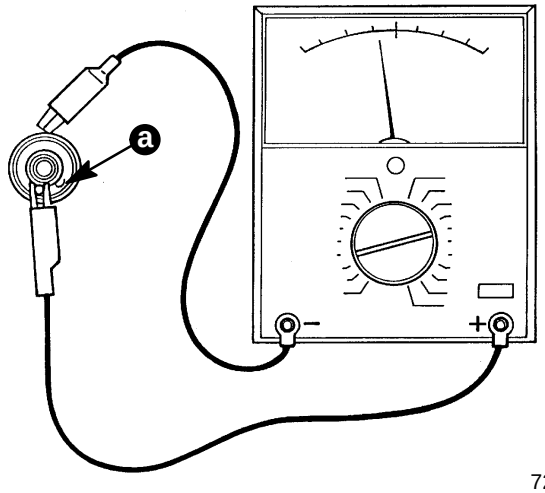
a - Ohmmeter Leads
b - Capsule Assembly
c - Magnet

5. Turn magnet counterclockwise until fuel capsule indicator reads EMPTY. Ohmmeter should read 240 ohms (± 5 ohms).



a - Capsule Reading Empty

6. Turn magnet clockwise until fuel capsule indicator reads FULL. Ohmmeter should read 30 ohms (± 5 ohms). Fuel capsule is defective if not within specifications.



72759

a - Capsule Reading Full

Switches

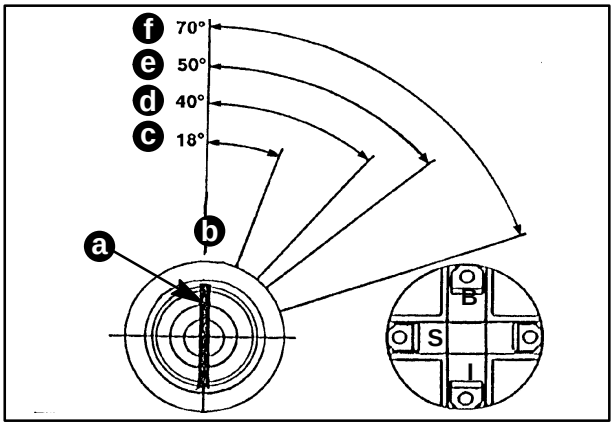
Ignition Key Switch

TESTING

⚠ CAUTION

Disconnect battery cables from battery before testing ignition key switch with wires still connected to switch.

1. Disconnect battery cables, if testing ignition key switch with wires connected to switch.
2. Before testing key switch, check all fuses and/or circuit breakers in electrical circuit which could prevent operation of starter.
3. With key switch in OFF position, there should be no continuity between switch terminals.
4. With key switch in RUN position, continuity will exist between switch terminals B to I. There should no continuity between terminal S and any other terminals.
5. With key switch in START, continuity will exist between terminals B to I and B to S.
6. Terminals are to make contact at angles shown and to stay in contact condition as switch is rotated toward START.
7. If ignition key switch tests bad, unsolder wire connections and remove switch. Test switch again, as in Steps 2-5, preceding. If switch tests good, wiring in harness is bad, There should be no continuity between any harness wires with key switch removed.



72760

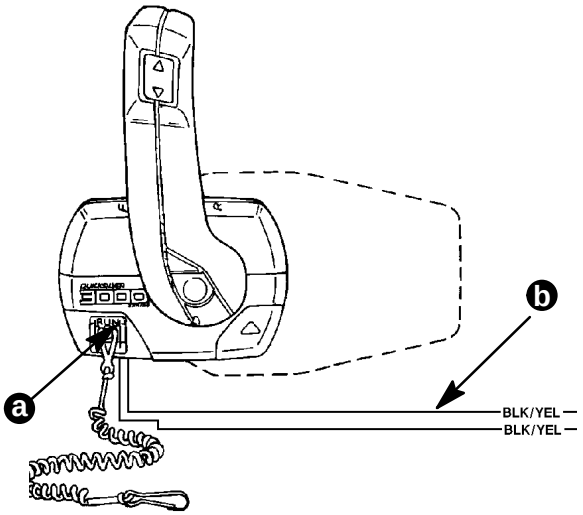
a - Key
b - Off
c - Continuity, B to I Terminals
d - Run
e - Continuity B to S Terminals
f - Start

Lanyard Stop Switches

NOTICE

For repair procedures on MPI / EFI Engines, refer to Section 5C.

TESTING

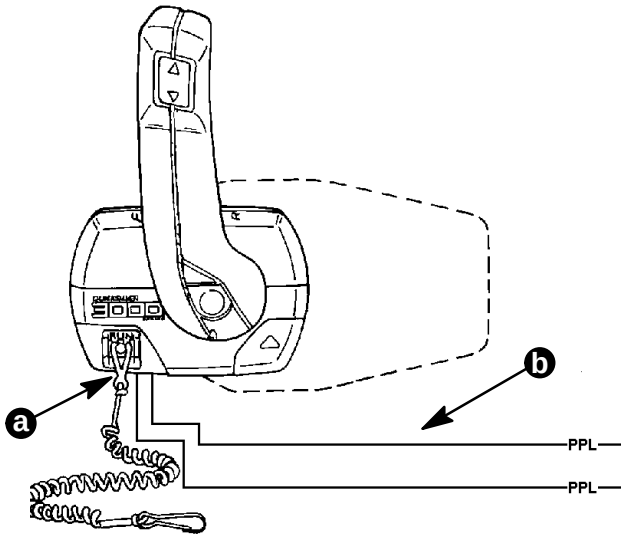


74061

Remote Control Mounted Style Switch - Electronic Fuel Injection (EFI) Engines

a - Switch Lanyard
b - Leads (BLK/YEL)

1. Disconnect switch leads.
2. Test switch as follows.
   a. Connect an ohmmeter to leads.
   b. There should be no continuity with switch lanyard connected and continuity with switch lanyard disconnected.

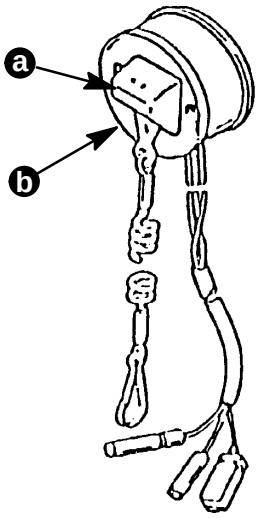


74062

Remote Control Mounted Style Switch - Carbureted Engines

a - Switch Leads
b - Leads (PUR)

1. Disconnect switch leads.
2. Test switch as follows.
   a. Connect an ohmmeter to leads.
   b. There should be continuity with switch lanyard connected and no continuity with switch lanyard disconnected.



72762

Toggle Style Switch

a - Switch Cap
b - Switch

IMPORTANT: The BLK/YEL lead is not used. It should be well insulated and taped to harness.

1. Disconnect switch leads.
2. Connect an ohmmeter to switch leads.
3. Switch should have continuity with toggle in the RUN position and no continuity with toggle in the OFF position.

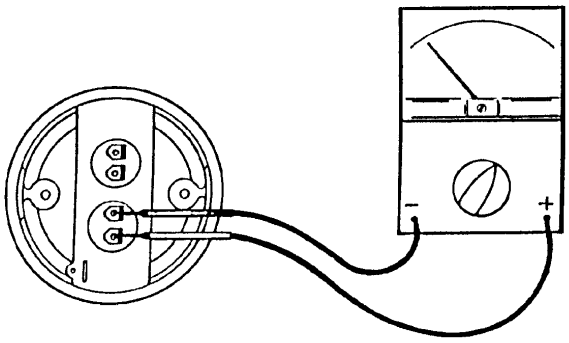
Start/Stop Switch

TESTING

⚠WARNING

Disconnect battery leads at battery before testing.

1. Disconnect battery leads.
2. Check for continuity between the terminals on the start switch with a continuity meter.



72763

3. No continuity should exist.
4. Depress switch button and continuity should exist.
5. Check stop switch in the same manner.
6. If continuity exists when in the OPEN (not depressed) state, replace panel button.

Audio Warning System

NOTICE

For repair procedures on Fuel Injection Engines, refer to Section 5C.

Buzzer

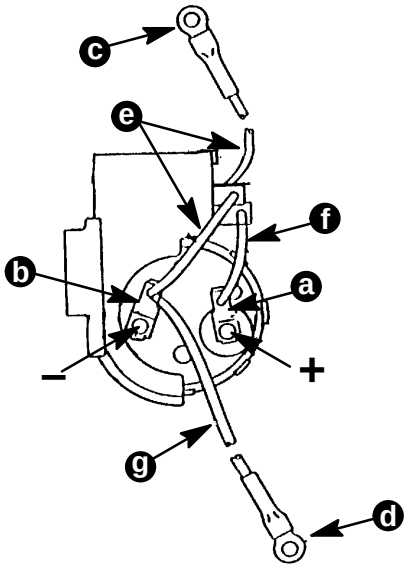
⚠WARNING

The following test involves the use of electricity. Failure to follow appropriate procedures can cause burns or shock which can result in severe personal injury or death.

TESTING

1. Turn key to RUN position (engine off).
2. Wait 7 to 14 seconds for horn to sound.
3. If horn does not sound:
   a. Connect jumper wires as shown.
   b. If horn does not sound, replace it.
4. If horn worked in Step 3:
   a. Connect jumper wires as shown.
   b. Repeat Step 2.

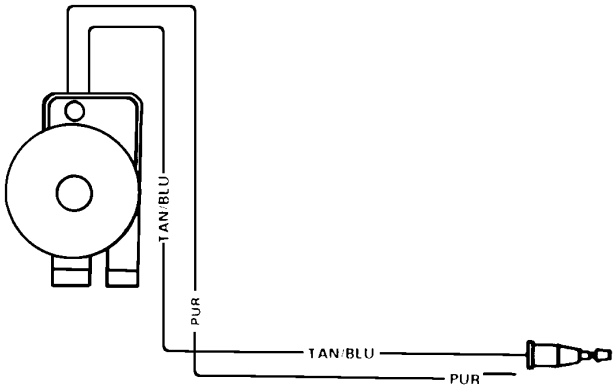
c. If horn sounds, problem is in tan/blue wire back to engine or switches on engine.



72612

Buzzer For 1994 Model And Older Carbureted Engines

a - Jumper Wire To 12 Volt (+) Step 3
b - Jumper Wire To Negative (–) Step 3
c - Jumper Wire To 12 Volt (+) Step 4
d - Jumper Wire To Negative (–) Step 4
e - PURPLE Wire
f - RED Wire
g - TAN/BLUE Wire



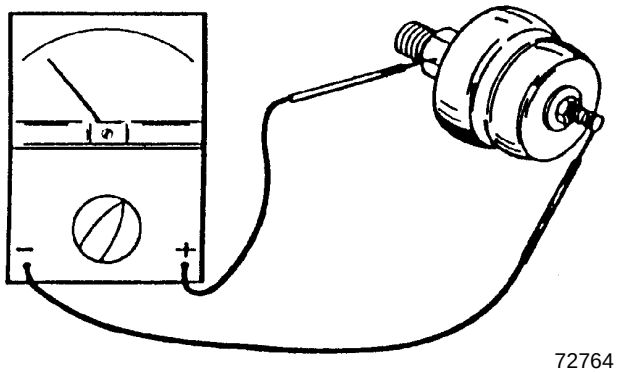
74046

Buzzer For EFI and 1995 Model And Newer Carbureted Engines (No Timer Circuit)

Oil Pressure Switch

TESTING

1. Remove wire from sender terminal.
2. Connect continuity meter between sender terminal and sender hex. (Sender shown removed for clarity.)



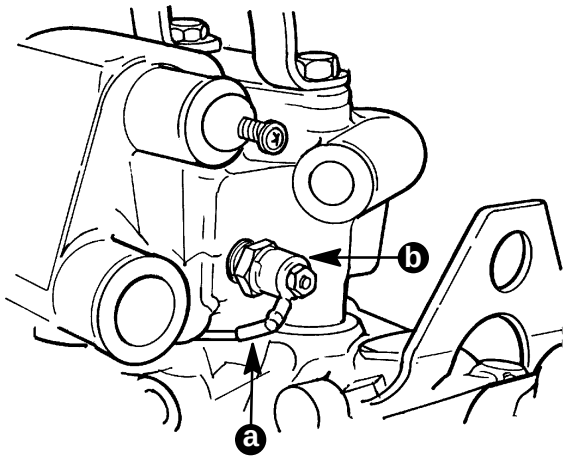
72764

3. With engine not running, meter should indicate full continuity.
4. Start engine. With engine running and engine oil pressure above 6 PSI (41 kPa), meter should indicate NO continuity.

Water Temperature Switch

REMOVAL

1. Drain coolant from closed cooling system into a suitable container as outlined in Section 6B.
2. Remove tan/blue wire from temperature switch.



72613

a - TAN/BLUE Wire
b - Water Temperature Switch

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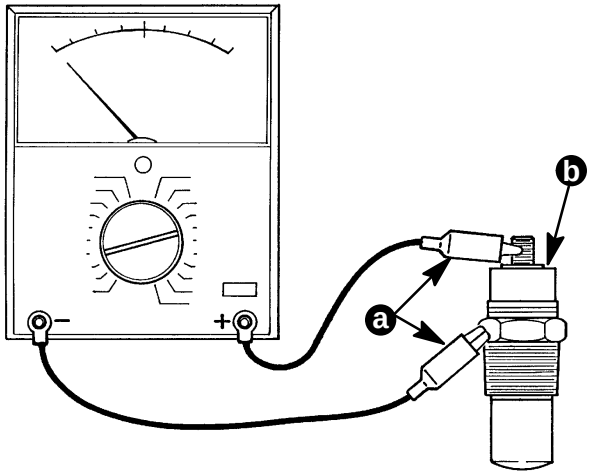
NOTE: *Coolant hoses shown removed for clarity.*

3. Remove switch.

TESTING

1. Connect an ohmmeter between water temperature switch terminal (+) and hex (case) for ground (–) as shown.



72765

a - Ohmmeter Leads
b - Water Temperature Switch

2. Switch should read no continuity.

⚠WARNING

The following test involves the use of intense heat. Failure to follow appropriate procedures or warnings can cause burns which can result in severe personal injury. While performing the following test, observe these general precautions:

- **Wear personal protective clothing such as rubber gloves, a non-flammable apron, and eye protection - preferably full face shield or safety glasses.**
- **The appropriate heat source should only be electric. Heat source should be operated by a qualified person. Be sure to follow all instructions of the manufacturer of the heat source. The heat source should be checked each time it is used to be sure it is functioning properly.**
- **The thermometer used in the test should be a high-temperature thermometer with a maximum reading of at least 300°F (150°C). Under no circumstances should the operator allow temperatures to exceed test specifications.**
- **Perform test only in a well ventilated area.**
- **Use a suitable container, such as metal, to hold the sand. Avoid use of glass containers unless the operator first confirms for himself/herself that the glass container is an appropriate high-temperature vessel.**
- **Because the components will reach high temperatures DO NOT handle materials or components until COMPLETELY cooled.**

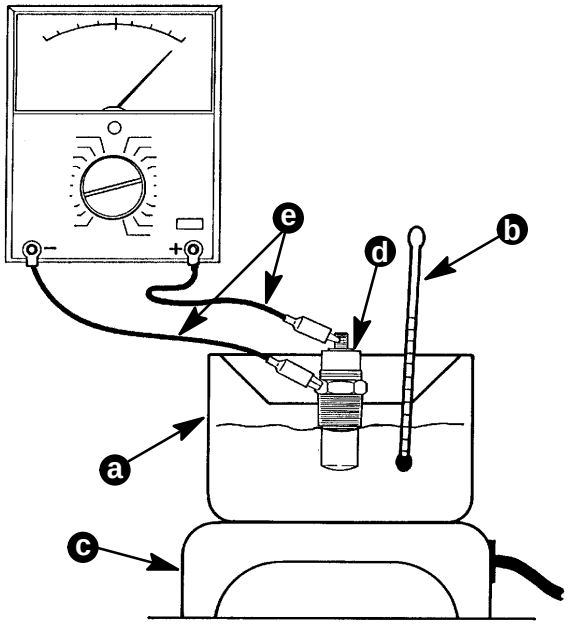
⚠ WARNING

Use only clean, dry sand such as used for general sandblasting purposes. Use of sand containing contaminants could result in hazards such as fire, short circuiting, hot-spots, or other hazards.

3. Follow these instructions:

   a. With an ohmmeter connected as outlined and using suitable container, thermometer and heat source, suspend sender with tip in sand.

   b. Heat sand and observe temperature on thermometer.



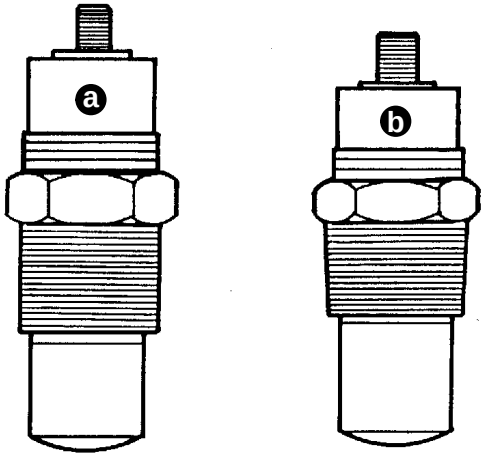
72766

a - Suitable Container
b - Thermometer
c - Heat Source
d - Water Temperature Switch
e - Ohmmeter Leads

   c. As temperature rises, switch will close and ohmmeter will indicate continuity. Refer to chart below for specifications.

48952 Switch	
Opens	150-170° F (60-77° C)
Closes	190-200° F (88-93° C)

87-86080 Switch	
Opens	175-195° F (60-77° C)
Closes	215-225° F (88-93° C)



72767

Switch Identification

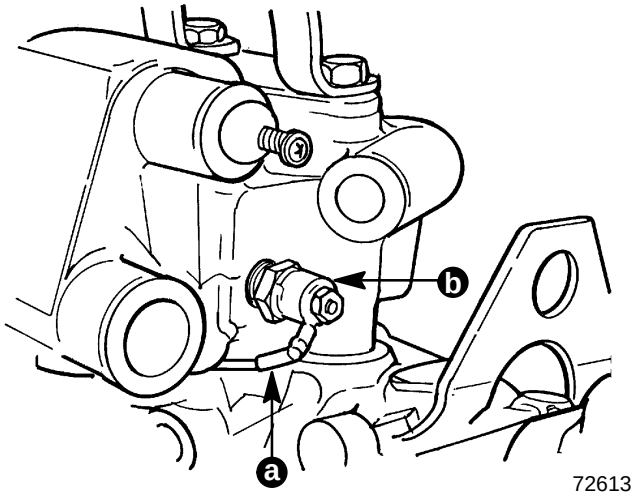
a - 48952 Switch With Red Mylar Sleeve
b - 87-86080 Switch With Black Mylar Sleeve

4. Turn heat source off. Allow sand to cool. Note thermometer reading to ensure switch “opens” up at specified temperature.

5. Replace switch if switch fails to either open or close within the specified temperatures.

INSTALLATION

1. Apply Loctite Pipe Sealant with Teflon to threads of water temperature switch.
2. Install switch in thermostat housing and tighten securely.
3. Connect tan/blue wire and coat connection with Liquid Neoprene.



72613

a - TAN / BLUE Wire
b - Water Temperature Switch

4. Refill closed cooling system with approved coolant as outlined in Section 6B.

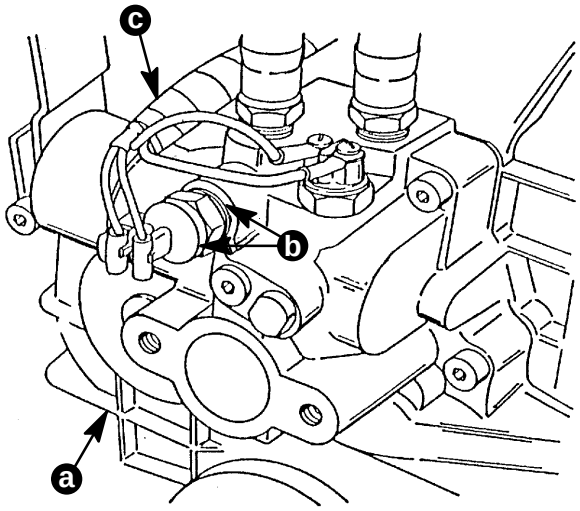
Transmission Fluid Temperature Switch

Switch is located on transmission. Switch is normally open. This switch is used on all MIE engines, if so equipped.

87-88031 Switch	
Opens	180-200° F (82-93° C)
Closes	220-240° F (104-116° C)

REMOVAL

1. Disconnect harness wires at switch.
2. Remove switch and sealing washer.

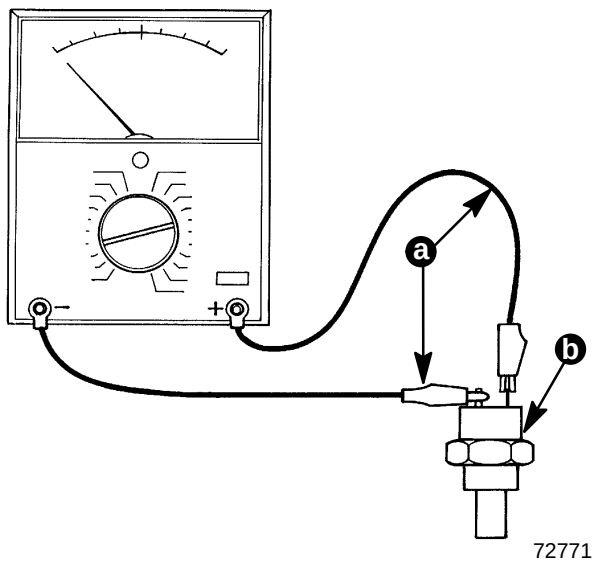


72770

a - Transmission (Typical)
b - Transmission Fluid Temperature Switch With Sealing Washer
c - Harness Wires

TESTING

1. Connect one lead of an ohmmeter to one terminal of transmission switch. Connect the other lead of ohmmeter to other terminal.



72771

a - Ohmmeter Leads
b - Transmission Fluid Temperature Switch

2. Switch should read no continuity.

⚠WARNING

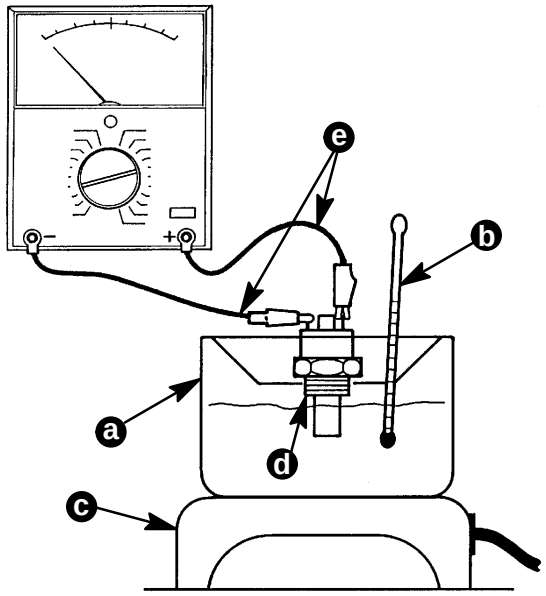
The following test involves the use of intense heat. Failure to follow appropriate procedures or warnings can cause burns which can result in severe personal injury. While performing the following test, observe these general precautions:

- **Wear personal protective clothing such as rubber gloves, a non-flammable apron, and eye protection - preferably full face shield or safety glasses.**
- **The appropriate heat source should only be electric. Heat source should be operated by a qualified person. Be sure to follow all instructions of the manufacturer of the heat source. The heat source should be checked each time it is used to be sure it is functioning properly.**
- **The thermometer used in the test should be a high-temperature thermometer with a maximum reading of at least 300°F (150°C). Under no circumstances should the operator allow temperatures to exceed test specifications.**
- **Perform test only in a well ventilated area.**
- **Use a suitable container, such as metal, to hold the sand. Avoid use of glass containers unless the operator first confirms for himself/herself that the glass container is an appropriate high-temperature vessel.**
- **Because the components will reach high temperatures DO NOT handle materials or components until COMPLETELY cooled.**

⚠WARNING

Use only clean, dry sand such as used for general sandblasting purposes. Use of sand containing contaminants could result in hazards such as fire, short circuiting, hot-spots, or other hazards.

3. Follow these instructions:
   a. With an ohmmeter connected as outlined and using suitable container, thermometer and heat source, suspend sender with tip in sand.
   b. Heat sand and observe thermometer.



72772

a - Sutiable Container
b - Thermometer
c - Heat Source
d - Transmisson Fluid Temperature Switch
e - Ohmmeter Leads

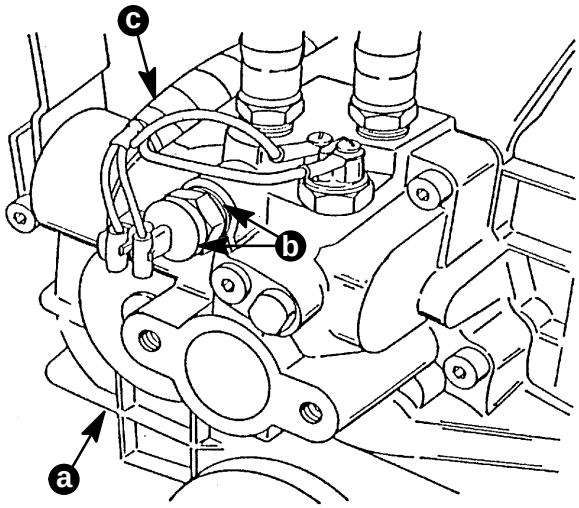
   c. As temperature rises, switch will close and ohmmeter will indicate continuity. Refer to chart below for specifications.

Switch Condition	Temperature
Opens	180-200° F (82-93° C)
Closes	220-240° F (104-116° C)

4. Turn heat source off. Allow sand to cool. Note thermometer reading to ensure switch opens up at specified temperature.
5. Replace switch if switch fails to either open or close within the specified temperature.

INSTALLATION

1. Apply Loctite Pipe Sealant with Teflon to threads of transmission fluid temperature switch.
2. Install switch with sealing washer in transmission and tighten securely.
3. Reconnect harness wires and coat with Liquid Neoprene.



72770

a - Transmission (Typical)
b - Transmission Fluid Temperature Switch With Sealing Washer
c - Harness Wires

4. Check transmission fluid level.

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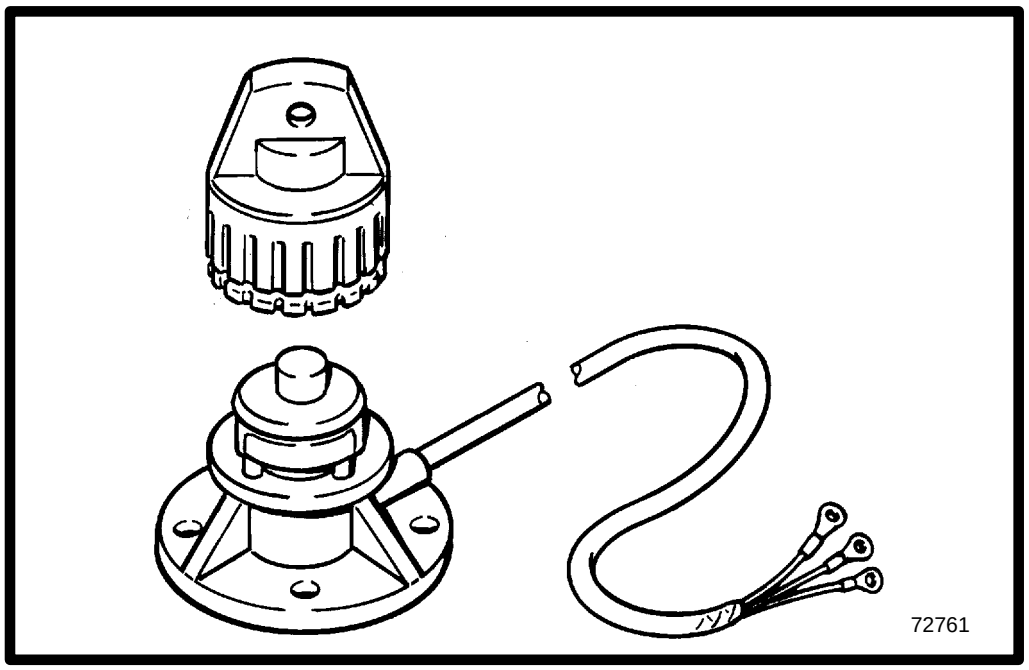
ELECTRICAL SYSTEM

4

E



ELECTRICAL KITS

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NOTICE

For information and procedures on Fuel Injection Engines, refer to Section 5C.

Wiring Color Code for MerCruiser Products

BLK = BLACK
BLU = BLUE
BRN = BROWN
GRY = GRAY
GRN = GREEN
ORN = ORANGE
PNK = PINK
PUR = PURPLE
RED = RED
TAN = TAN
WHT = WHITE
YEL = YELLOW
LIT = LIGHT
DRK = DARK

Lanyard Stop Switches

⚠ WARNING

Disconnect battery leads at battery before attempting to install ignition safety stop switch.

⚠ CAUTION

This stop switch is to be used as a safety stop switch only. It should not be used as the normal engine shut-off.

⚠ WARNING

As we cannot possibly know of and advise the boating public of ALL conceivable boat/motor types and/or poor operating practices, the final decision of whether to install and use a LANYARD STOP SWITCH, rests with the owner/driver.

⚠ CAUTION

Before cutting any holes in dashboard, check area behind dashboard for obstructions (braces, cables, etc.).

65503A2 Kit

INSTALLATION INFORMATION

1. Route stop switch wire harness to engine so that it will not chafe or flex unnecessarily. Secure harness with cable ties provided.
2. Check stop switch operation after installation is completed.
3. Coat all electrical connections with Quicksilver Liquid Neoprene after checking switch operation.
4. Attach stop switch cap to operator's person with a suitable cord (lanyard). Length of cord should be no longer than absolutely necessary and should have a minimum breaking strength of 100 lbs. (45 kg).

IMPORTANT: To prevent the possibility of damage to ignition components, turn ignition switch to OFF position as soon as possible after safety stop switch has been activated.

5. To reset stop switch after activation, simply install stop switch cap with a straight firm push.

87-19674A2 or 87-814324A2 Kit

INSTALLATION INFORMATION

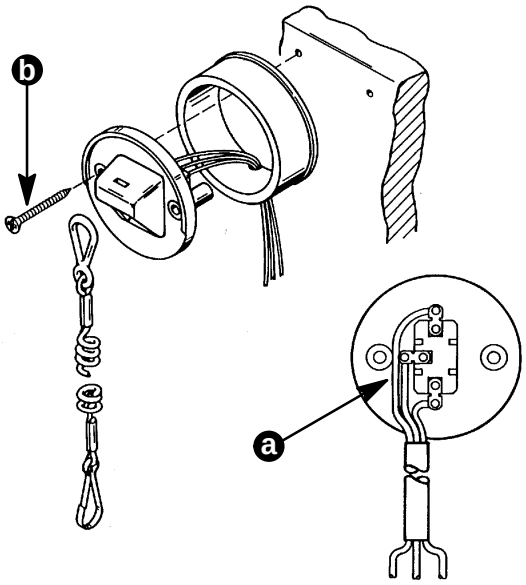
1. Select a location for lanyard stop switch that will allow lanyard to be pulled free without interference and will be within wire length limitations.
2. Mark hole locations for flush or surface mounting. Install switch assembly as shown.

IMPORTANT: If using "Surface Mount" configuration (as shown following), ensure wires are routed to the outside, as shown, to prevent pinching of wires between the back of switch and the mounting surface.

Drilling Tips

If dashboard is fiberglass, apply masking tape to area that is to be drilled to prevent dashboard from cracking.

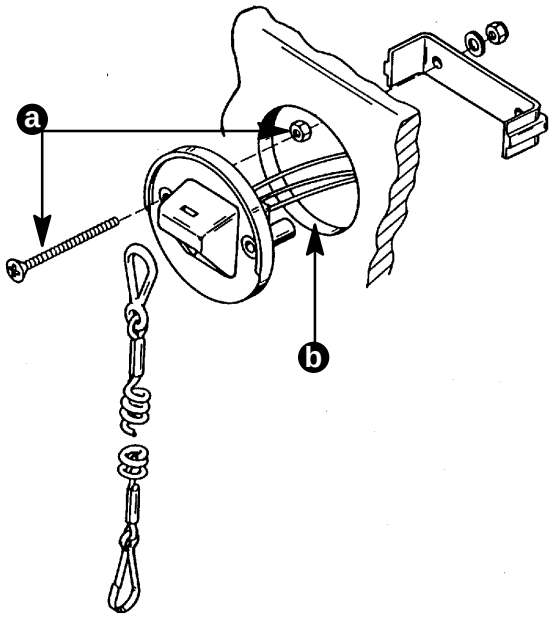
If dashboard is vinyl covered, use a razor blade to remove vinyl from area to be drilled to keep vinyl from tearing.



72807

Surface Mount - Single Engine

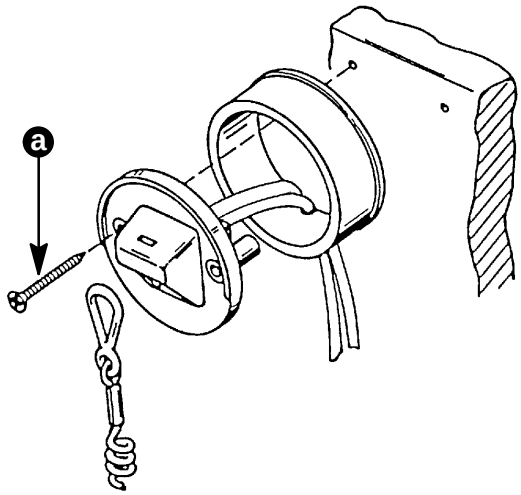
a - Wires Properly Routed
b - Self-Tapping Screw - Drill Pilot Holes Appropriate Drill Bit
Aluminum - 5/32 in. (4 mm)
Wood / Fiberglass 11/64 in. (4.5 mm)



72808

Flush Mount - Single Engine

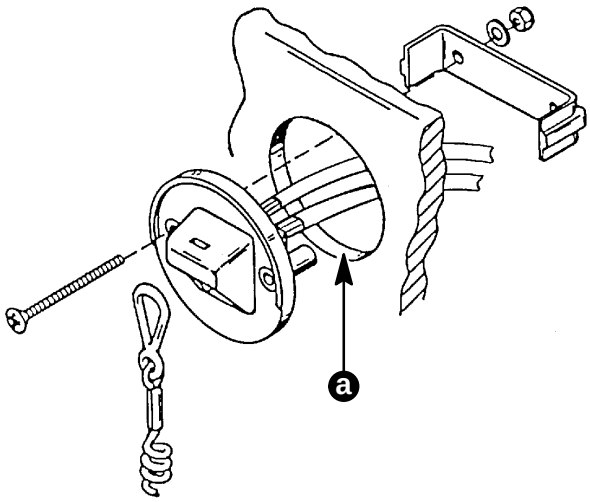
a - Secure Mounting Screws With Nuts To Aid Installation
b - 2-1/8 in. (54 mm) Hole - Use Hole Saw



72809

Surface Mount - Dual Engines

a - Self-Tapping Screw - Drill Pilot Holes Appropriate Drill Bit
Aluminum - 5/32 in. (4 mm)
Wood / Fiberglass 11/64 in. (4.5 mm)



72810

Flush Mount - Dual Engines

a - 2-1/8 in. (54 mm) Hole - Use Hole Saw

IMPORTANT: Be sure to refer to appropriate wiring diagram in the following step.

IMPORTANT: Lanyard stop switch being installed at second station (flybridge) must use Extension Harness Kit (84-16866A2) to connect switch to wiring harness at main (lower) station. Refer to instructions in extension harness kit.

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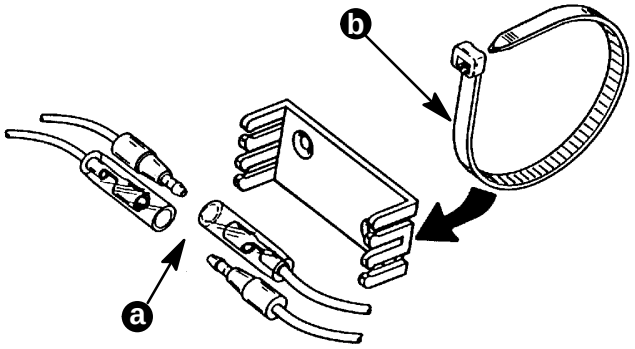
3. Connect lanyard stop switch wires in accordance with appropriate wiring diagram. Route switch wires to prevent possible chafing or flexing during boat operation. Secure wires with Sta-Straps.
4. Secure bullet connectors with retainer and Sta-Straps.



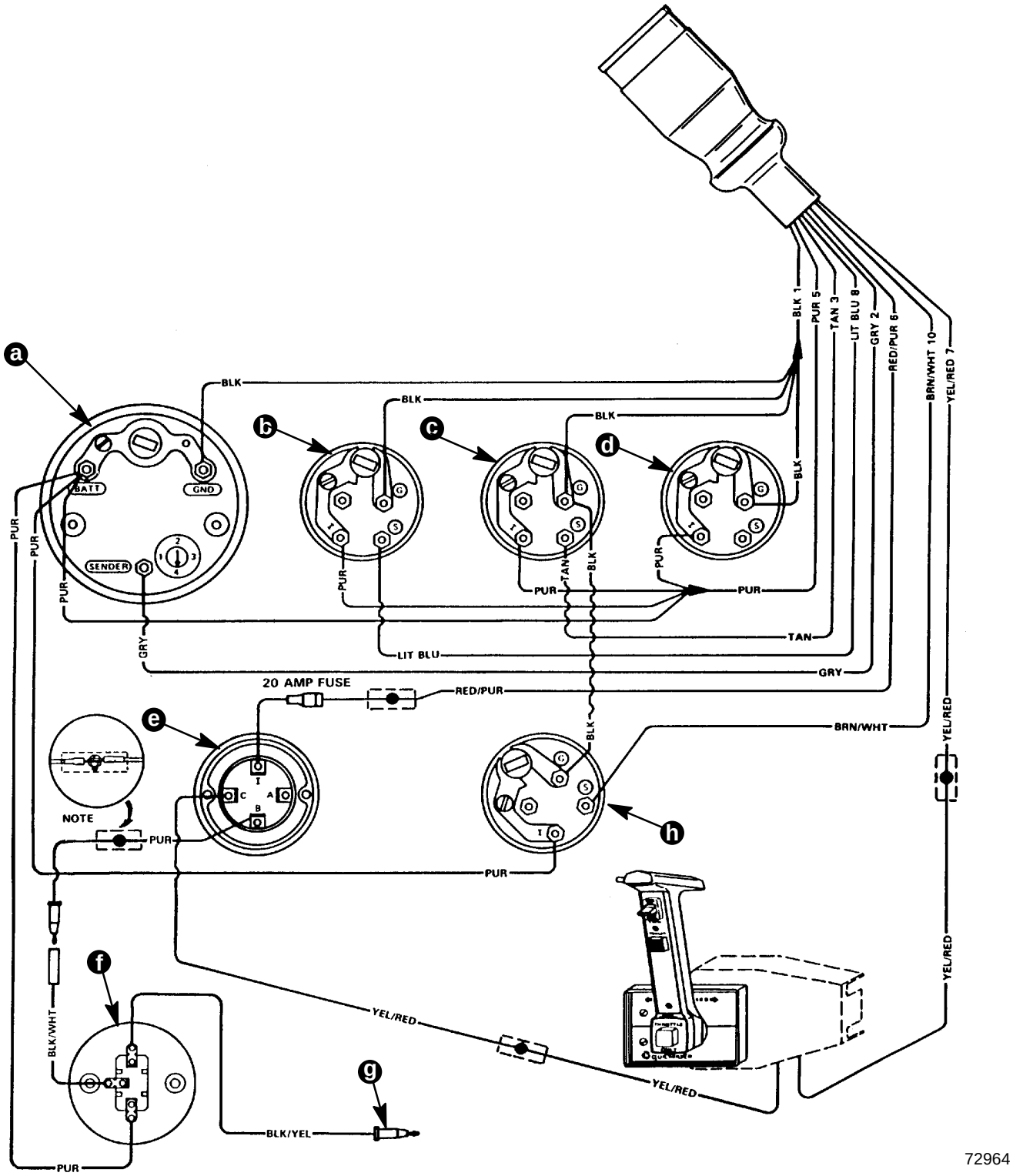
72811

a - Join Connectors
b - Secure With Sta-Strap

5. When installation is complete, reconnect battery leads at battery and perform operational test.

IMPORTANT: On installations where gauge options will not be used, tape back and isolate any unused leads.

LANYARD STOP SWITCH WIRING DIAGRAM - SINGLE ENGINE



NOTE: *Connect wires together with screw and hex nut. Apply Liquid Neoprene to connection and slide rubber sleeve over connection.*

a - Tachometer
b - Oil Pressure
c - Water Temperature
d - Battery Meter
e - Ignition Switch
f - Lanyard Stop Switch
g - This Lead Not Used On MerCruiser
h - Trim Indicator

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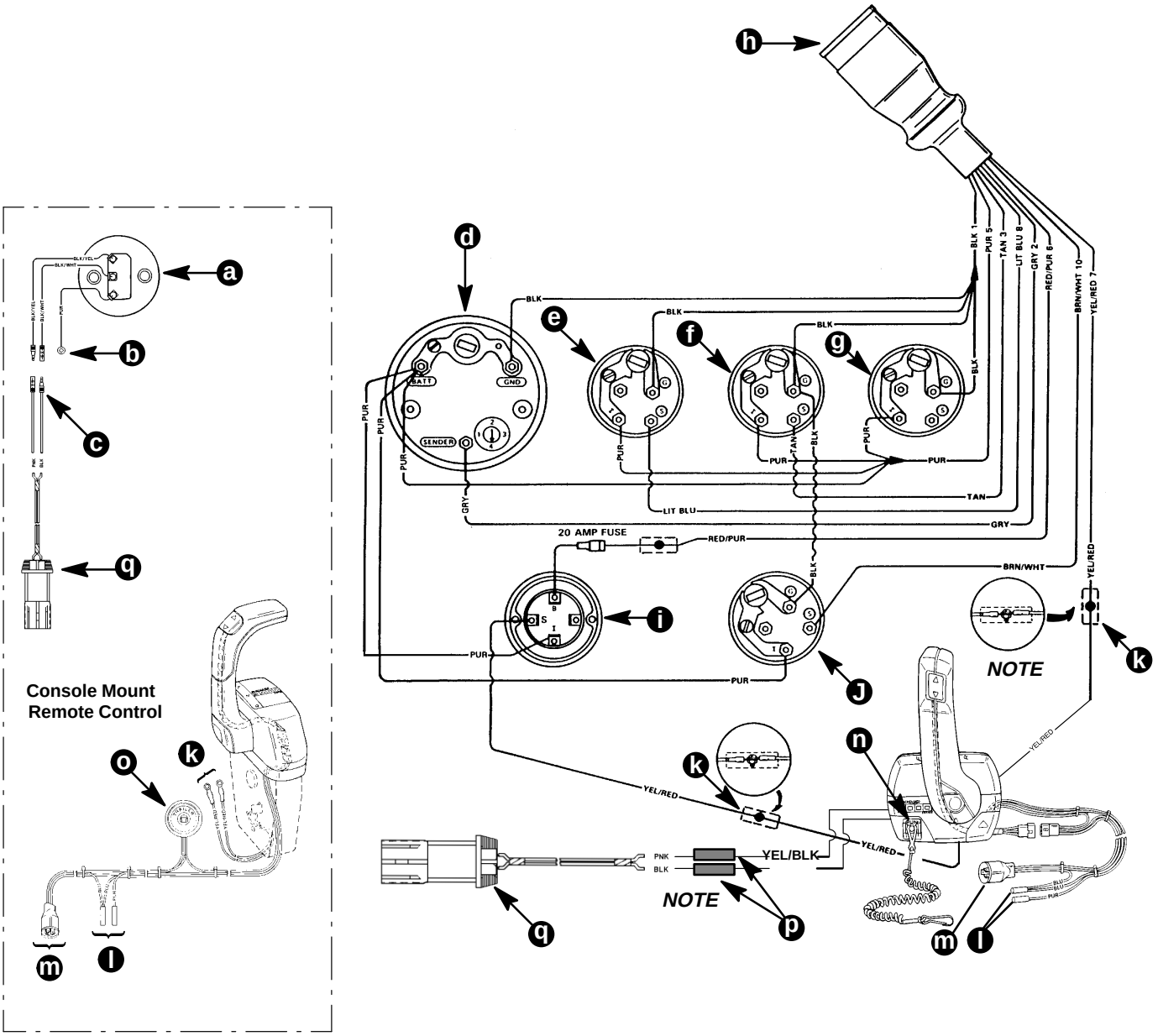
LANYARD STOP SWITCH WIRING DIAGRAM - SINGLE FUEL INJECTION ENGINE



NOTE: *Lanyard stop switch and neutral start leads must be soldered and covered with shrink tube for a water proof connection. If alternate method of connection is made (use of electrical butt connector) verify connection is secure and sealed for waterproof connection.*

a - Lanyard Stop Switch (Use With Console Mount Remote Control)
b - Lead Not Used On 454 / 502 Multi-Port Injection
c - Lanyard Stop Switch Multi-Port / Throttle Body Injection Adapter Harness
d - Tachometer
e - Oil Pressure
f - Water Temperature
g - Battery Meter
h - To Engine Harness
i - Ignition Switch
j - Trim Indicator
k - Neutral Start Switch Leads
l - Trim Limit Switch Leads
m - Power Trim Harness Connector
n - Lanyard StopSwitch (Panel Mount Remote Control)
o - Trialer Switch (Console Mounted Remote Control)
p - Lanyard Stop Leads On Panel Mounted Control
q - Lanyard Stop Switch Multi-Port / Throttle Body Injection Adapter Harness (84-805745A2) Purchased Seperate

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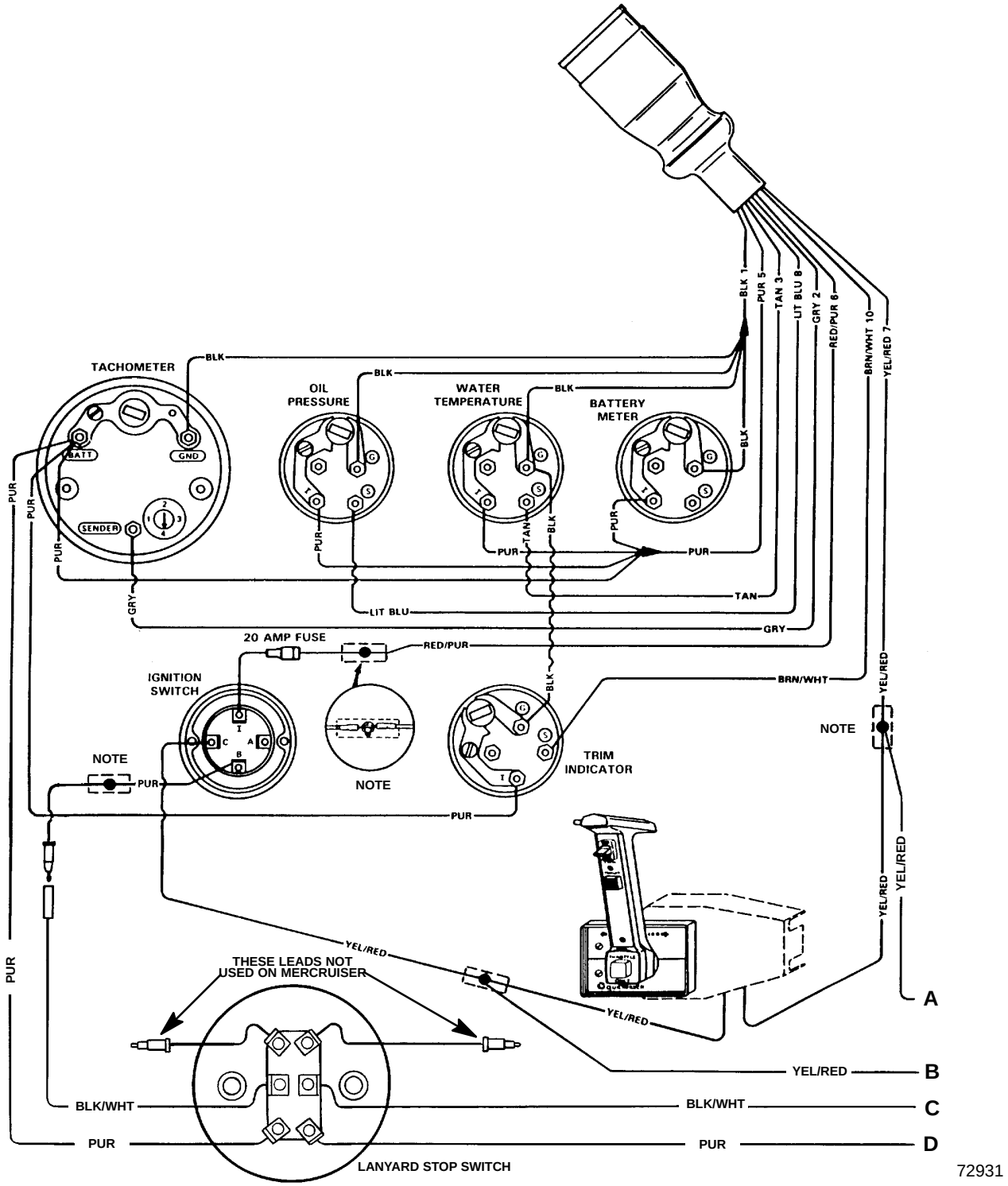
LANYARD STOP SWITCH WIRING DIAGRAM - DUAL ENGINES



IMPORTANT: On installations where gauge options will not be used, tape back and isolate any unused leads.

NOTE: *Connect wires together with screw and hex nut. Apply Liquid Neoprene to connection and slide rubber sleeve over connection.*

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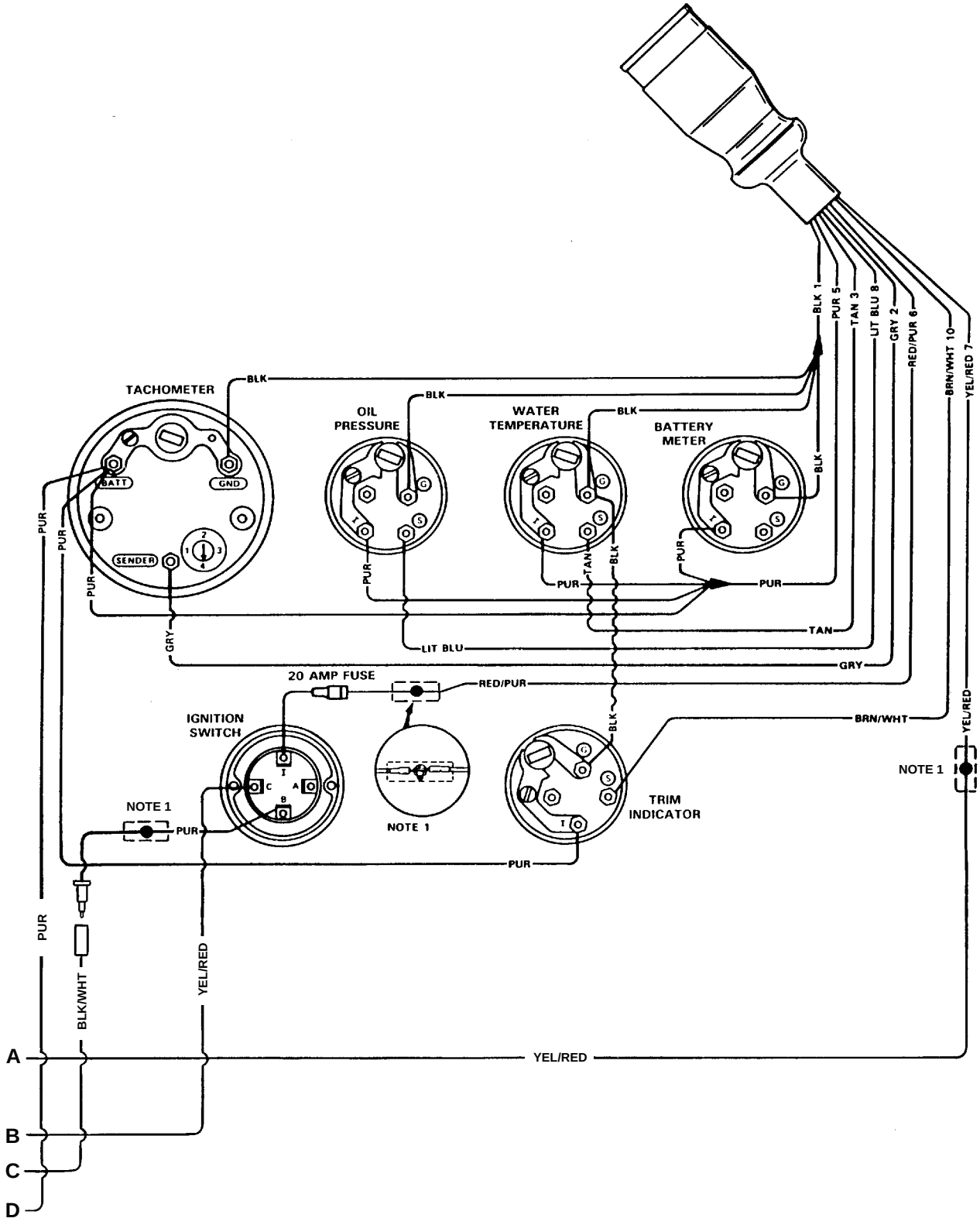
LANYARD STOP SWITCH WIRING DIAGRAM - DUAL ENGINES



72932

Audio Warning System

⚠ WARNING

Always disconnect battery cables from battery before working around electrical system components to prevent injury to yourself and damage to electrical system.

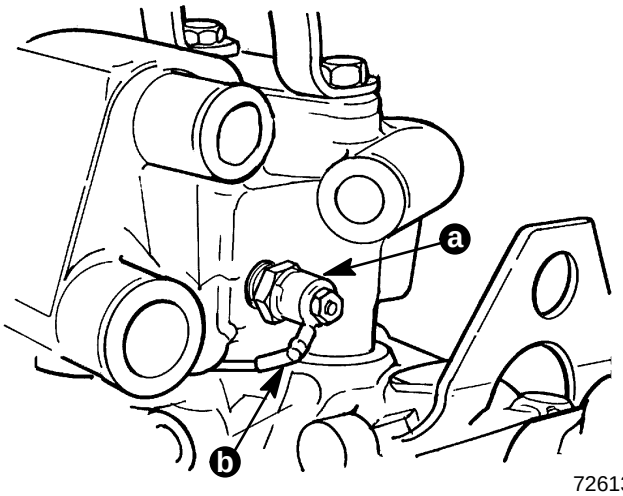
86047A14 Kit

INSTALLATION INFORMATION

Audio Warning Heat Switch on V-8 Engines with Standard Cooling

1. Drain cooling system.
2. Disconnect port hoses from thermostat housing.
3. Remove TAN/BLUE wire from water heat switch in port side of thermostat housing. Remove switch.

NOTE: *Hoses shown removed for clarity.*



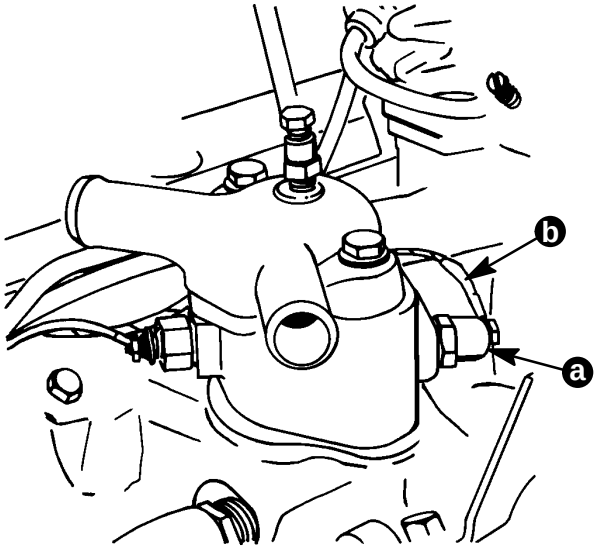
72613

a - Audio Warning Heat Switch
b - TAN / BLUE Wire

4. Install audio warning heat switch as follows:
   a. Install heat switch into aft side of thermostat housing, using Loctite Pipe Sealant with Teflon (DO NOT use Teflon tape) to seal threads. Tighten securely.
   b. Attach TAN/BLUE wire to heat switch with nut and lockwasher. Tighten nut securely.
   c. Coat connections with Quicksilver Liquid Neoprene.
5. Reconnect water hoses.

Audio Warning Heat Switch on V-8 Engines with Closed Cooling

1. Drain cooling system.
2. Remove TAN/BLUE wire from audio warning heat switch in rear hole of thermostat housing. Remove switch.



71518

a - Audio Warning Heat Switch
b - TAN / BLUE Wire

3. Install audio warning heat switch as follows:
   a. Install heat switch into thermostat housing, using Loctite Pipe Sealant with Teflon (DO NOT use Teflon tape) to seal threads. Tighten securely.
   b. Attach TAN/BLUE wire to heat switch with nut and lockwasher. Tighten nut securely.
   c. Coat connections with Quicksilver Liquid Neoprene.
4. Fill closed cooling system with proper water/anti-freeze solution. (Refer to “Filling Closed Cooling Section” in Section 6B.)

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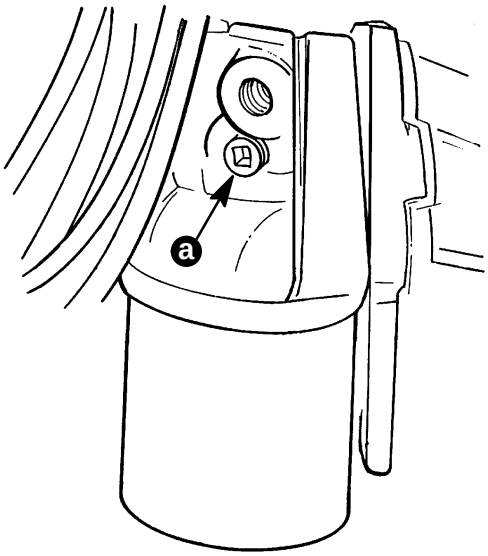
Audio Warning Oil Pressure Switch

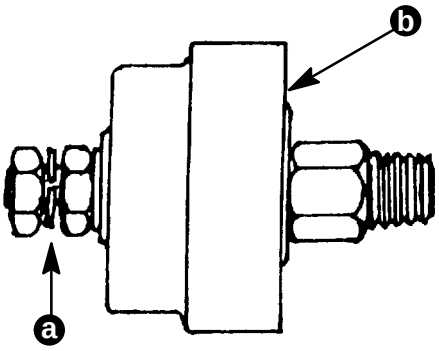
1. Audio warning oil pressure switch (with reducer) is installed in place of engine block plug at the following location:



72820

a - Engine Block Plug (Typical)

2. Disconnect TAN/BLUE wire (from audio warning heat switch) at audio warning oil pressure switch.

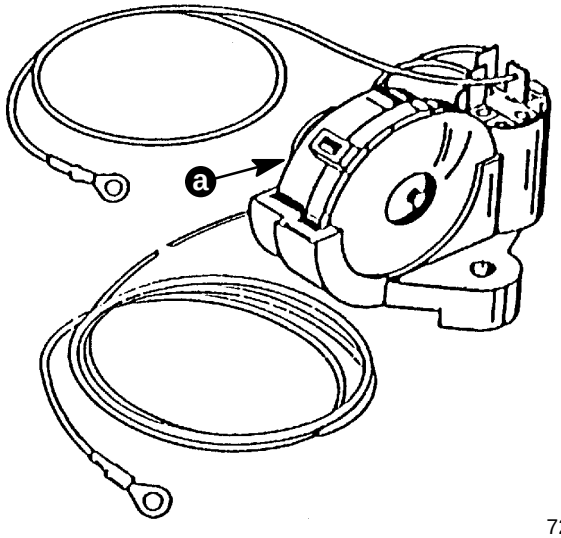


72812

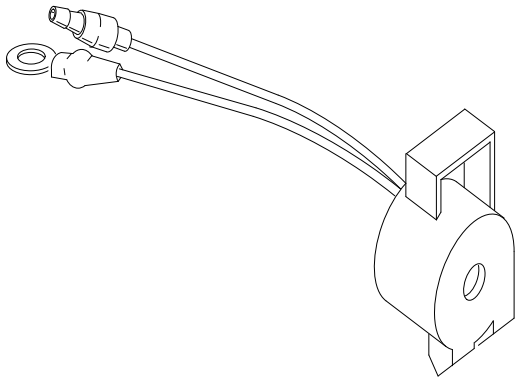
a - TAN / BLUE Wire Location (Wire Not Shown)
b - Audio Warning Oil Pressure Switch

3. Remove audio warning oil pressure switch.
4. Install switch as follows:
   a. Install switch using Loctite Pipe Sealant with Teflon (DO NOT use Teflon tape) to seal threads. Tighten switch securely.
   b. Coat connections with Quicksilver Liquid Neoprene.
   c. Connect TAN/BLUE wire from audio warning heat switch to audio warning oil pressure switch with lockwasher and nut. Torque nut to 15 lb. in. (1.7 N·m).

Warning Buzzer



72813



a - Early Style Warning Buzzer
b - Later Style Warning Buzzer

⚠WARNING

Buzzer is not external ignition-proof; therefore, DO NOT mount buzzer in engine or fuel tank compartments.

1. Disconnect battery leads, if not already disconnected.

2. Mount buzzer under dashboard with two screws (from kit) in location that is not in obvious sight but is easily accessible for installation and maintenance. Location should not restrict buzzer sound and also should be within limits of 18 in. (460 mm) PURPLE lead. (Lead will be connected to instrument terminal in dashboard.)
3. Attach PURPLE lead to +12 volt switched terminal of any adjacent gauge [PURPLE to PURPLE (BIA)]. The attaching terminal should be OFF when ignition switch is in the OFF position.
4. Plug male terminal of TAN/BLUE wire (on buzzer) to existing TAN/BLUE wire on harness. Be sure that wire does not chafe or get pinched and does not come in contact with bilge water or moving parts.
5. Connect TAN/BLUE lead from buzzer to engine water heat switch with lockwasher and nut. Torque nut to 15 lb. in. (1.7 N·m). (DO NOT over-tighten).
6. Place decal (Figure 1) on bottom of glass face of water temperature gauge and of oil pressure gauge, if equipped.

ALARM INDICATES LOW OIL OR OVERHEATING

Figure 1

7. Place decal (Figure 2) in convenient location on dashboard.

ENGINE SENSOR HORN WILL SOUND WHEN OIL PRESSURE IS TOO LOW OR TEMP. IS TOO HOT.
TO TEST HORN
1.TURN KEY TO ON POSITION (ENGINE OFF)
2. WAIT 7 TO 14 SEC. FOR HORN TO SOUND

Figure 2

8. Reconnect battery leads.
9. Fill closed cooling system (on engines so equipped) with water/antifreeze solution.
10. Test switch (horn) as explained on decal (Figure 1).
11. Seal all electrical connections with Quicksilver Liquid Neoprene.

OPERATION

Test the system (per the instructions on the dashboard decal, Figure 2) at least once every five hours of operation.

During boat operation, if the horn sounds, look for one or more of the following operation problems:

PROBLEM	REMEDY
Low Engine Oil (Check Oil Pressure Gauge or Dipstick Level)	Add Oil Per Instructions in Owner's Manual
Cooling Water Pickup is Blocked Or Clogged (Check Water Temperature Gauge)	Clear The Water Pickup Of Foreign Material

NOTE: *The horn will sound, if, while docking or otherwise maneuvering slowly, the engine stalls and is not restarted, and the ignition key is left ON (similar to test procedure).*

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ELECTRICAL SYSTEMS

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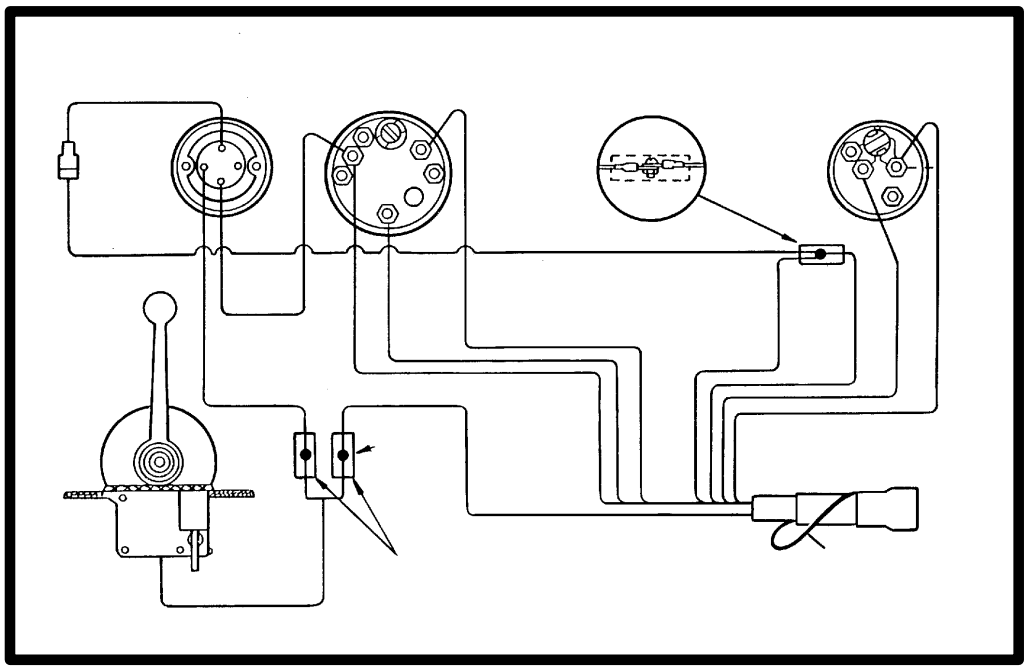

WIRING DIAGRAMS

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Wiring Colors for MerCruiser

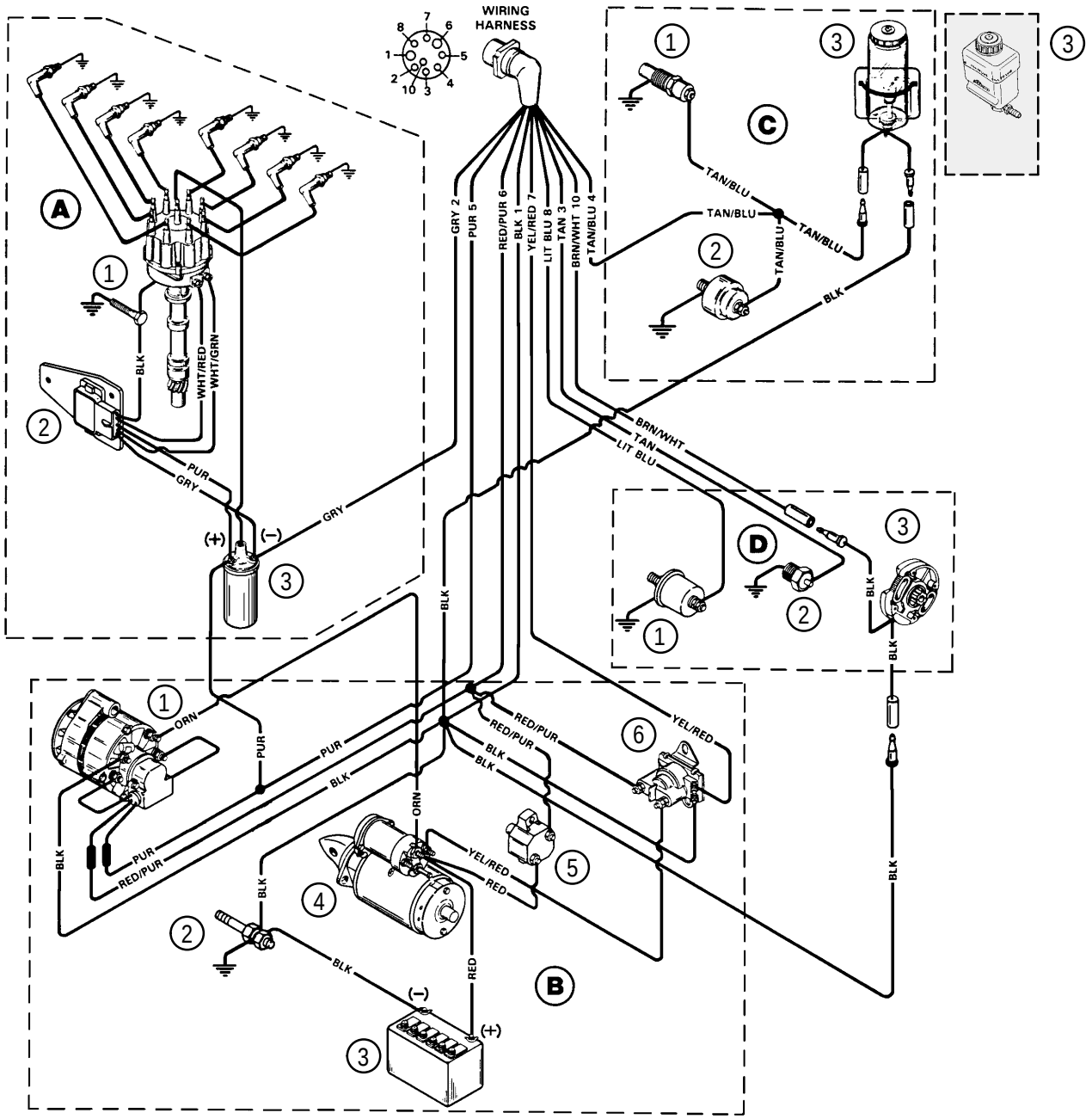
NOTE: *Color codes listed below DO NOT apply to fuel injection system harnesses.*

BIA COLOR CODE AND ABBREVIATIONS	WHERE USED
BLACK (BLK)	All Grounds
BROWN (BLU)	Reference Electrode - MerCathode
ORANGE (ORN)	Anode Electrode-MerCathode
LT. BLUE/WHITE (LT BLU/WHT)	Trim - “Up” Switch
GRAY (GRY)	Tachometer Signal
GREEN/WHITE (GRN/WHT)	Trim - “Down” Switch
TAN (TAN)	Water Temperature Sender to Gauge
LIGHT BLUE (LIT BLU)	Oil Pressure Sender to Gauge
PINK (PNK)	Fuel Gauge Sender to Gauge
BROWN/WHITE (BRN/WHT)	Trim Sender to Trim Gauge
PURPLE/WHITE (PUR/WHT)	Trim - “Trailer” Switch
RED (RED)	Unprotected Wires from Battery
RED/PURPLE (RED/PUR)	Protected (Fused) Wires from Battery
RED/PURPLE (RED/PUR)	Protected (+12V) to Trim Panel
ORANGE (ORN)	Alternator Output
PURPLE/YELLOW (PUR/YEL)	Ballast Bypass
PURPLE (PUR)	Ignition Switch (+12V)
YELLOW/RED (YEL/RED)	Starter Switch to Starter Solenoid to Neutral Start Switch

Engine

MCM (Stern Drive)

THUNDERBOLT IV WITH IGNITION MODULE MOUNTED ON EXHAUST ELBOW



50844

A - Ignition And Choke System

1 - Distributor
2 - Ignition Module
3 - Ignition Coil

B - Starting And Charging System

1 - Alternator
2 - Ground Stud
3 - Battery
4 - Starter Motor
5 - Circuit Breaker
6 - Starter Slave Solenoid

C - Audio Warning System

1 - Oil Pressure Sender
2 - Water Temperature Sender
3 - Trim Sender

D - Instrumentation System

1 - Water Temperature
2 - Oil Pressure Switch
3 - Drive Unit Oil Bottle (Old And New Style)

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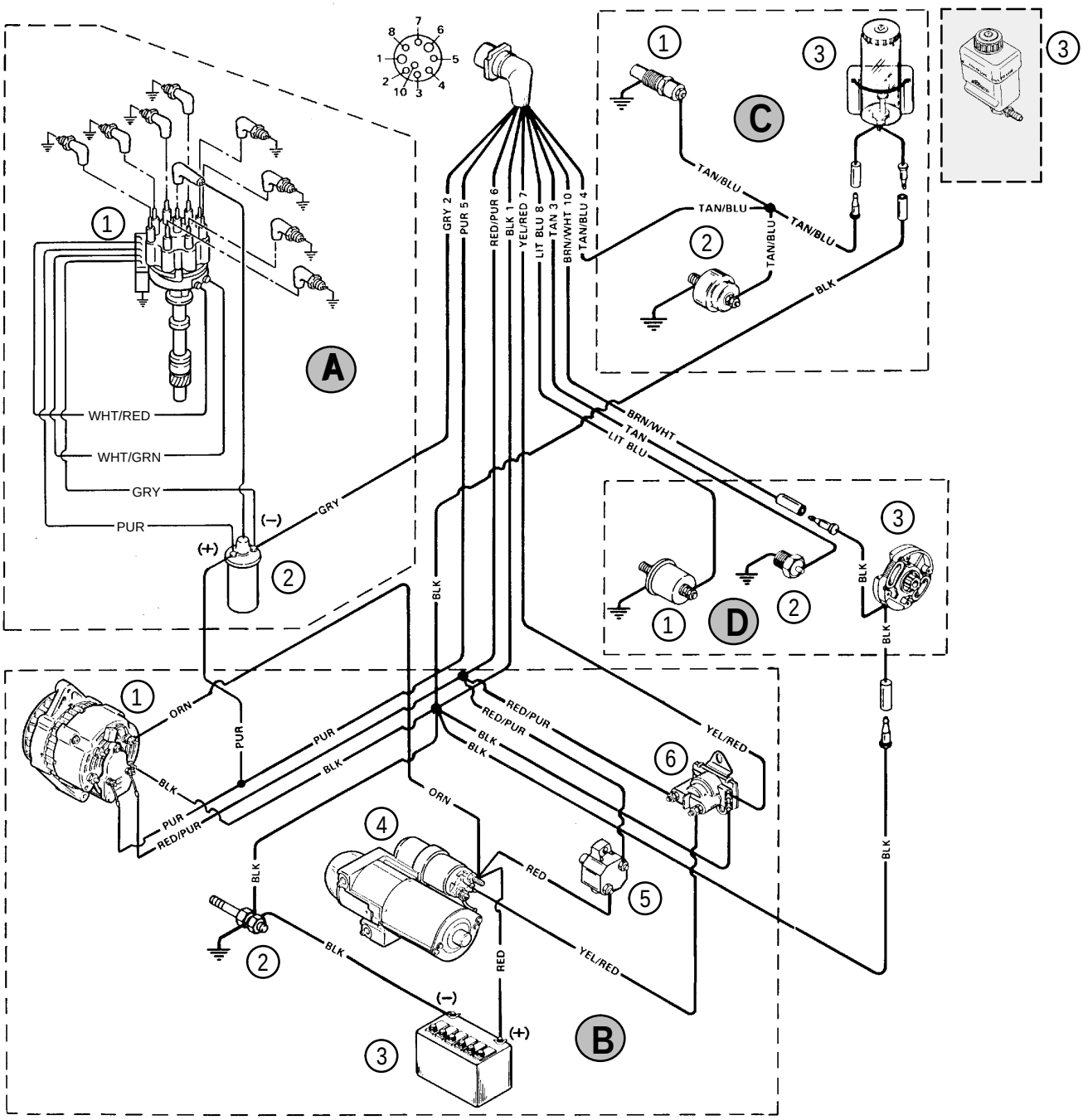
THUNDERBOLT IV WITH IGNITION MODULE MOUNTED ON DISTRIBUTOR



72936

A - Ignition And Choke System

1 - Distributor With Ignition Module
2 - Ignition Module
3 - Ignition Coil

B - Starting And Charging System

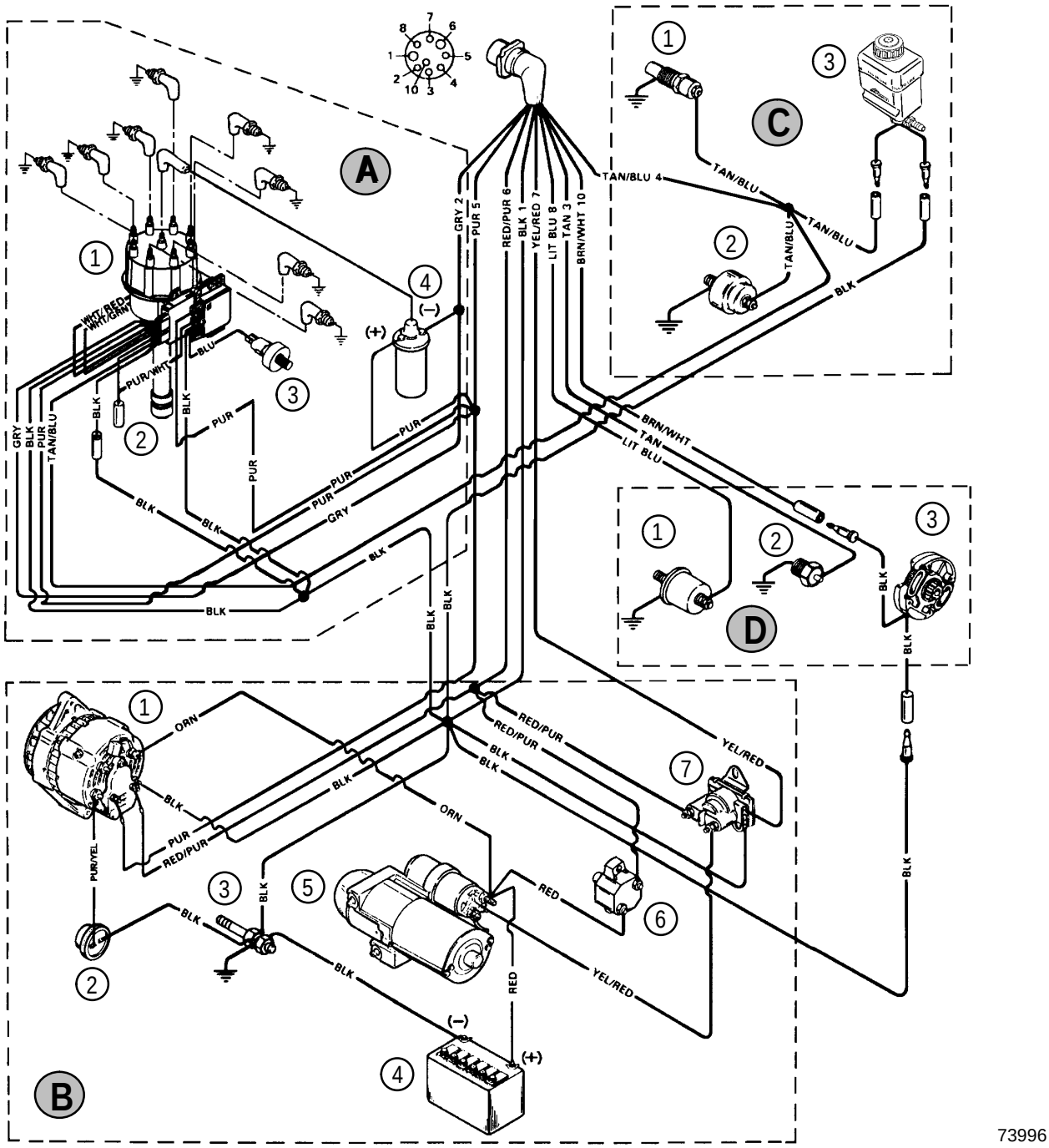
1 - Alternator
2 - Ground Stud
3 - Battery
4 - Starter Motor
5 - Circuit Breaker
6 - Starter Slave Solenoid

C - Audio Warning System

1 - Oil Pressure Sender
2 - Water Temperature Sender
3 - Trim Sender

D - Instrumentation System

1 - Water Temperature
2 - Oil Pressure Switch
3 - Drive Unit Oil Bottle (Old And New Style)



73996

A - Ignition And Choke System

1 - Distributor With Ignition Module
2 - Timing Lead
3 - Knock Sensor
4 - Ignition Coil

B - Starting And Charging System

1 - Alternator
2 - Electric Choke
3 - Ground Stud
4 - Battery
5 - Starter Motor
6 - Circuit Breaker
7 - Starter Slave Solenoid

C - Audio Warning System

1 - Oil Pressure Sender
2 - Water Temperature Sender
3 - Trim Sender

D - Instrumentation System

1 - Water Temperature
2 - Oil Pressure Switch
3 - Drive Unit Oil Bottle (Old And New Style)

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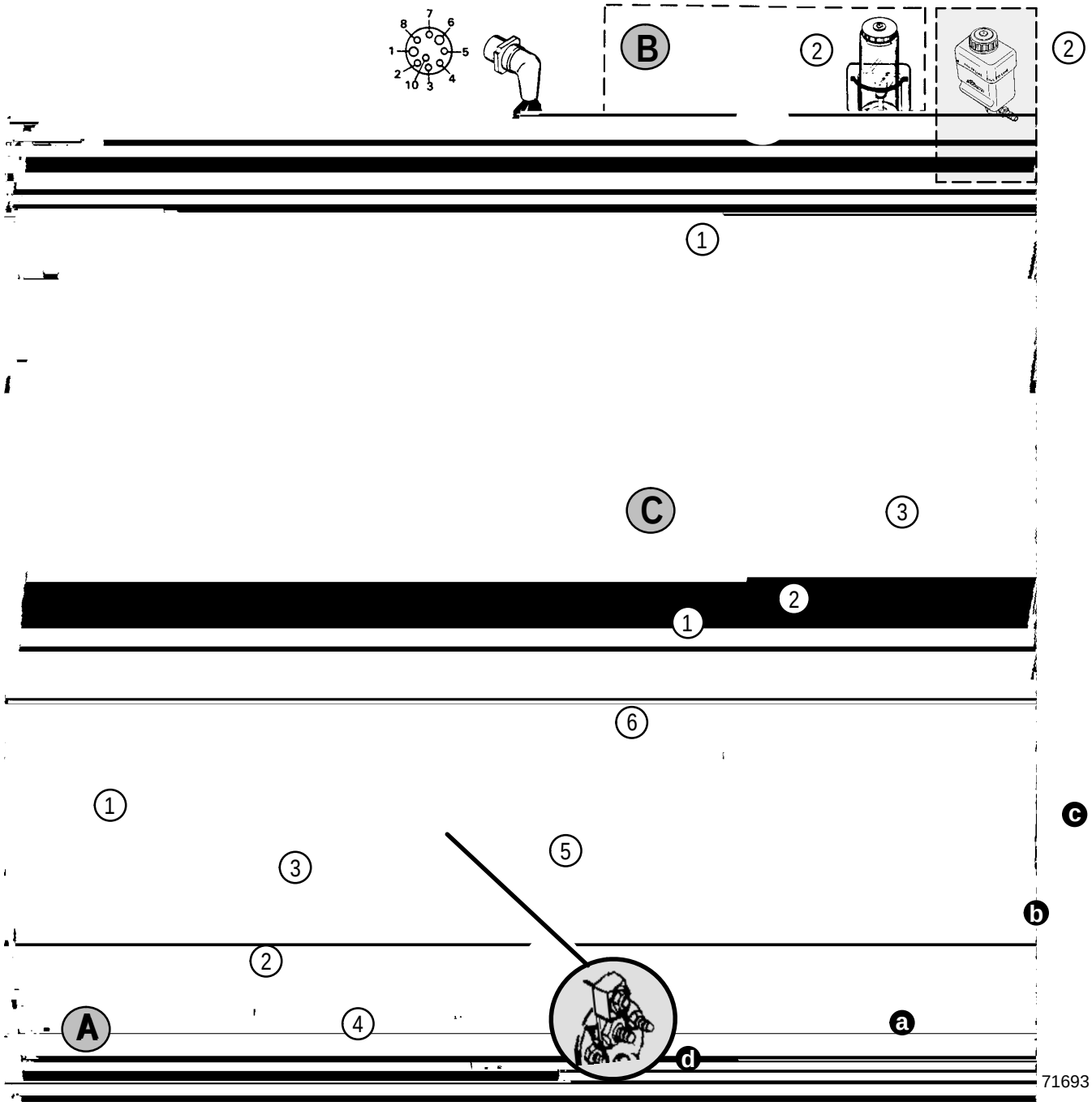
ALL MCM THROTTLE BODY / MULTI-PORT INJECTION STARTING AND CHARGING DIAGRAM



A - Charging And Starting System

1 - Alternator
2 - Ground Stud
3 - Starter Motor
4 - Battery
5 - Circuit Breaker
6 - Starter Slave Solenoid

B - Audio Warning System / Power Reduction Circuit (Not Present On 1996 And Newer Models)

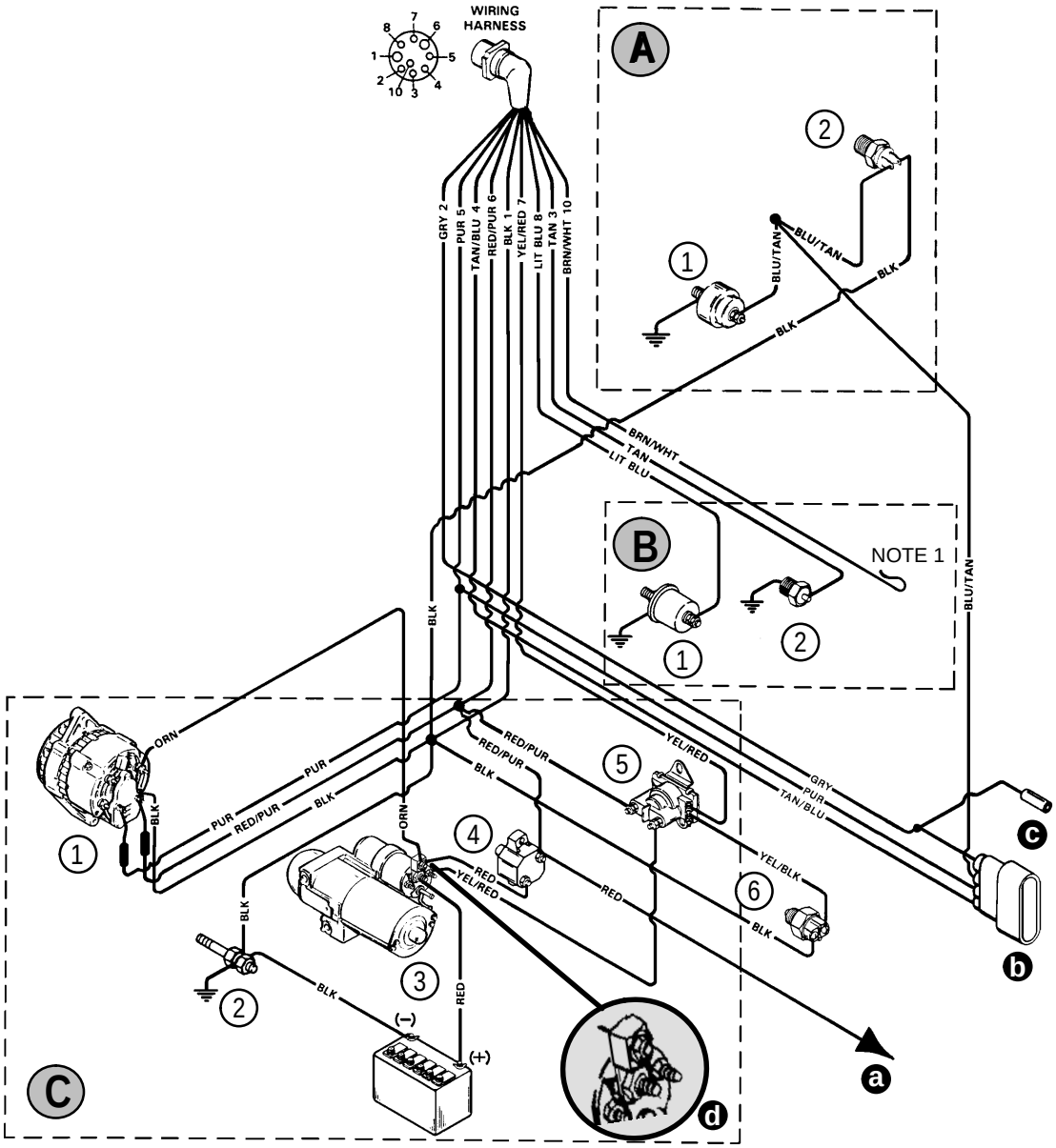
1 - Oil Pressure
2 - Drive Unit Oil Level Bottle (New And Old Style)

C - Instrumentation System

1 - Oil Pressure Sender
2 - Water Temperature Sender
3 - Trim Sender

a - Positive (12V) Power Wire To Furl Injection System Harness
b - Harness Connector To Fuel Injection System Harness
c - Auxiliary Tachometer Lead
d - 90 Amp. Fuse (DO NOT Remove)

ALL THROTTLE BODY / MULTI-PORT INJECTION INBOARD AND SKI ENGINES



NOTE 1: Taped back BROWN and BLACK wire may be used for an accessory. LOAD MUST NOT EXCEED 5 AMPS

A - Audio Warning System

1 - Oil Pressure Switch
2 - Transmission Fluid Temperature

B - Instrumentation System

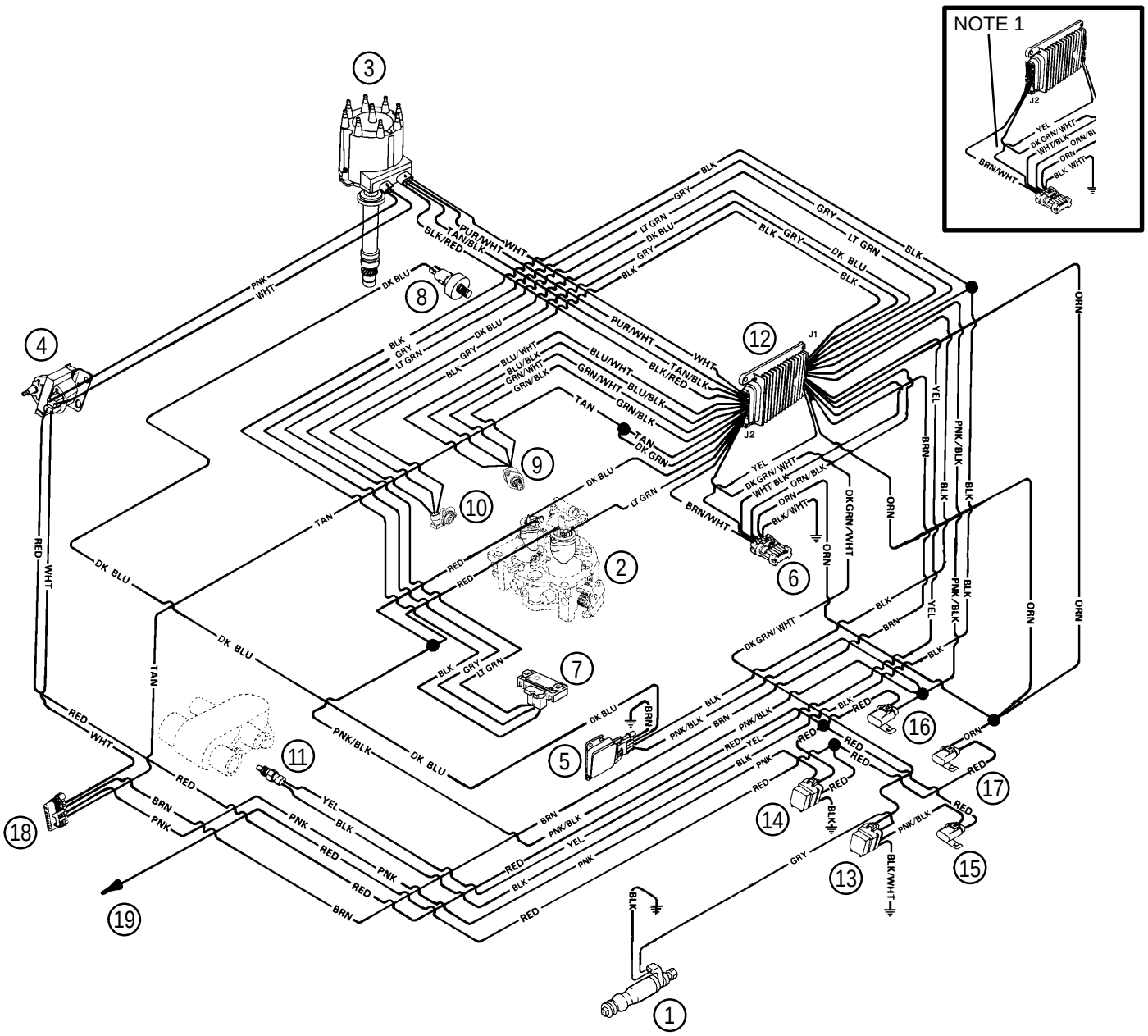
1 - Oil Pressure Sender
2 - Water Temperature Sender

C - Charging And Starting System

1 - Alternator
2 - Ground Stud
3 - Starter
4 - Circuit Breaker
5 - Starter Slave Solenoid
6 - Neutral Safety Switch

a - Positive (12V) Power Wire To Fuel Injection System Harness
b - Harness Connector To Fuel Injection System Harness
c - Auxiliary Tachometer Lead
d - 90 Amp. System Fuse

MCM 7.4LX / MIE 7.4L THROTTLE BODY INJECTION



Note: All BLACK Wires With A Ground Symbol Are Interconnected Within The Fuel Injection System Harness.

NOTE 1: As a mid year (96-1/2) model change, the Throttle Body and Multi-Port Injection models have the lanyard stop connector removed from the wiring harness. The dual engine capability is relocated by routing the YEL wire to the Data Link Connector (DLC).

1 - Fuel Pump
2 - Throttle Body
3 - Distributor
4 - Coil
5 - Electronic Spark Control (KS) Module
6 - Data Link Connector (DLC)
7 - Manifold Absolute Pressure (MAP) Sensor
8 - Knock Sensor
9 - Idle Air Control (IAC)
10- Throttle Position (TP) Sensor
11- Engine Coolant Temperature (ECT) Sensor
12- Electronic Control Module (ECM)
13- Fuel Pump Relay
14- Ignition/System Relay
15- Fuse (15 Amp) Fuel Pump
16- Fuse (15 Amp) ECM/DLC/Battery
17- Fuse (10 Amp) ECM/Injector/Ignition/Knock Module
18- Harness Connector To Starting/Charging Harness
19- Positive (+) Power Wire To Engine Circuit Breaker

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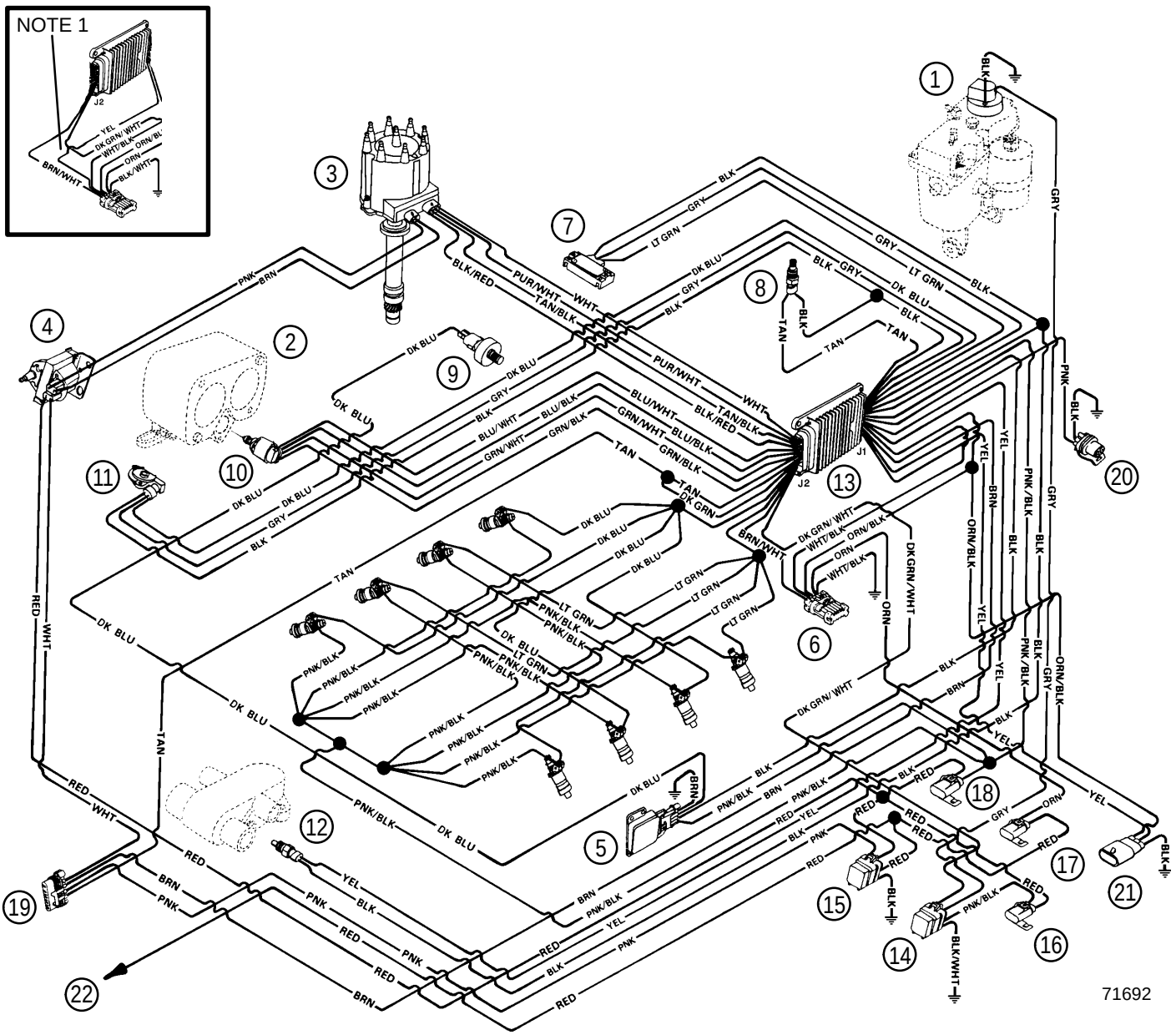
7.4L / 7.4LX / 454 / 502 MULTI-PORT MAGNUM ENGINE DIAGRAM MODELS WITH VST



NOTE 1: As a mid year (96-1/2) model change, the Throttle Body and Multi Port Injection models have the lanyard stop connector removed from the wiring harness. The dual engine capability is relocated by routing the YEL wire to the Data Link Connector (DLC).

NOTE 2: All BLACK wires with a ground symbol are interconnected within the fuel injection system harness.

1 - Vapor Separator Tank
2 - Throttle Body
3 - Distributor
4 - Coil
5 - Knock Sensor (KS) Module
6 - Data Link Connector (DLC)
7 - Manifold Absolute Pressure (MAP) Sensor
8 - Intake Air Temperature (IAT) Sensor
9 - Knock Sensor (KS)
10- Idle Air Control (IAC)
11- Throttle Positive Sensor (TP)
12- Engine Coolant Temperature (ECT) Sensor
13- Electronic Control Module (ECM) Sensor
14- Fuel Pump Relay
15- Ignition Relay
16- Fuel Pump Relay (15 Amp)
17- Injector Fuse 15 Amp.) ECM, DLC, Battery
18- ECM Fuse (10 Amp.) ECM, Ignition, Injectors, Knock Sensor Module
19- Harness Connector To Starting / Charging Harness
20- Harness Connector To Lanyard Stop Switch (Optional)
21- Harness Connector For Dual Engine Data Link Cable
22- Positive (+) Power Wire To Engine Circuit Breaker

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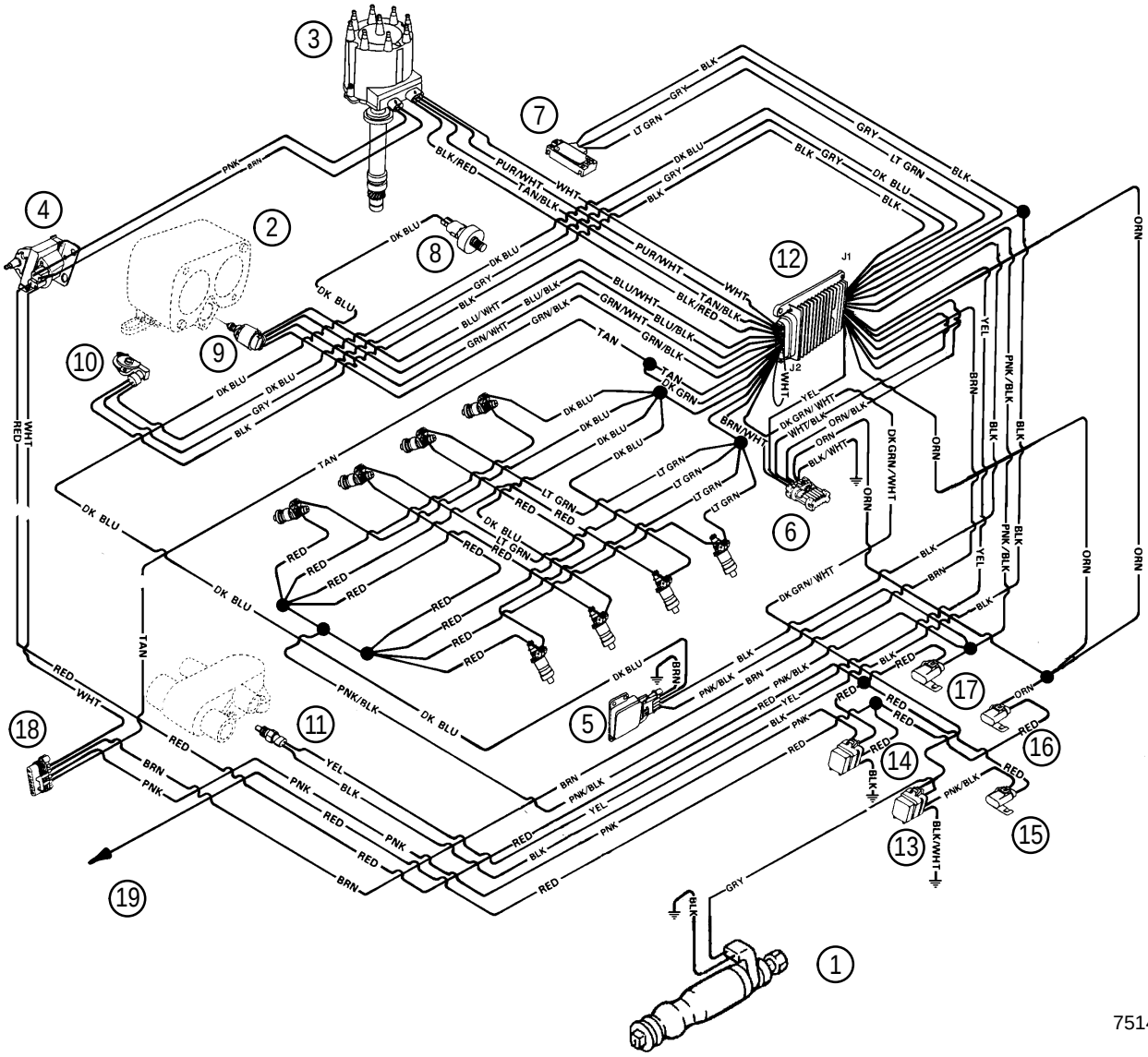
7.4L / 7.4LX / 454 / 502 MULTI-PORT MAGNUM ENGINE DIAGRAM MODELS WITH COOL FUEL SYSTEM



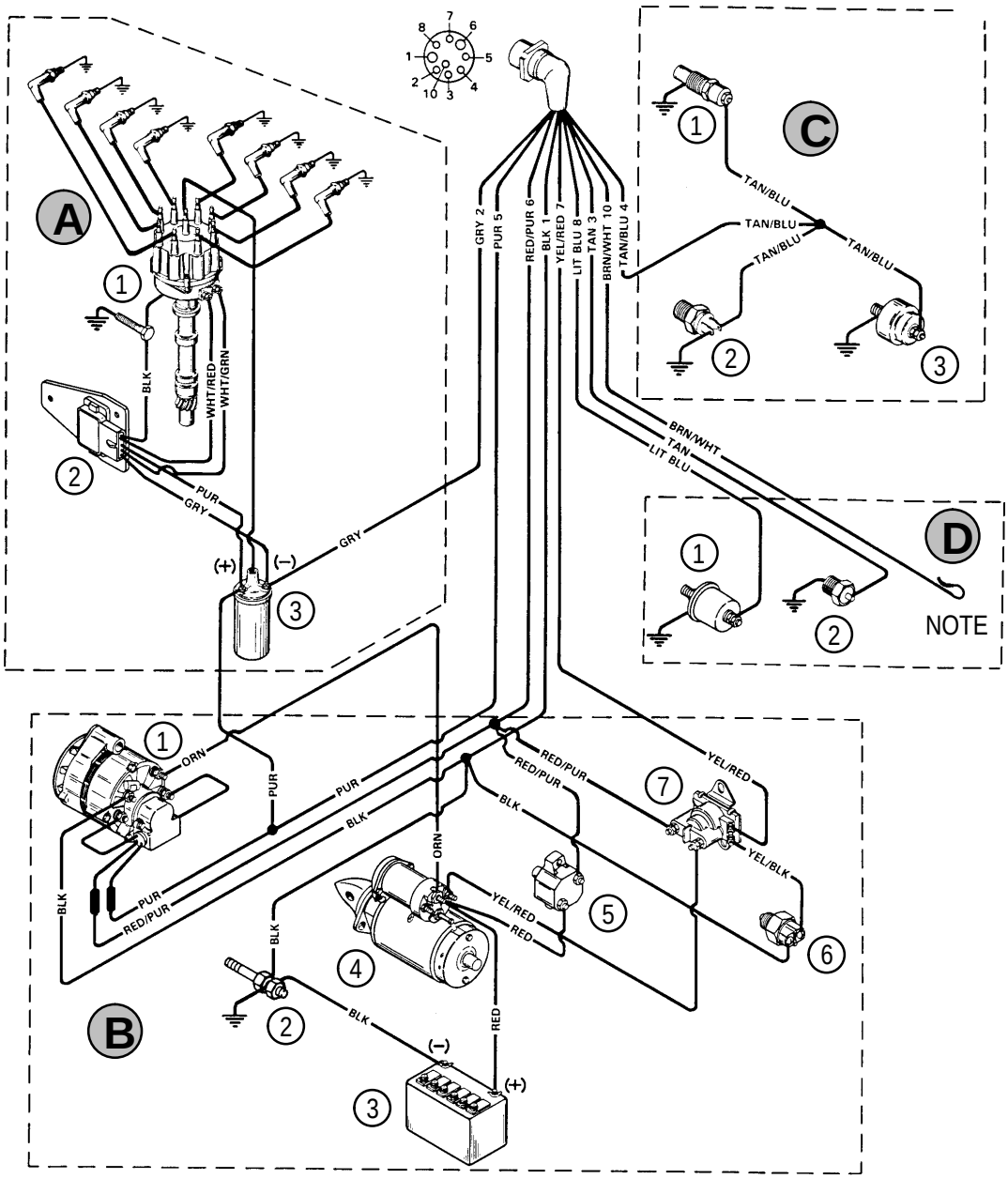
75146

NOTE: *All BLACK wires with a ground symbol are interconnected within the EFI system harness.*

1 - Fuel Pump
2 - Throttle Body
3 - Distributor
4 - Coil
5 - Electronic Spark Control (KS) Module
6 - Data Link Connector (DLC)
7 - Manifold Absolute Pressure (MAP) Sensor
8 - Knock Sensor
9 - Idle Air Control (IAC)
10- Throttle Position (TP) Sensor
11- Engine Coolant Temperature (ECT) Sensor
12- Electronic Control Module (ECM)
13- Fuel Pump Relay
14- Ignition/System Relay
15- Fuse (15 Amp) Fuel Pump
16- Fuse (15 Amp) ECM/DLC/Battery
17- Fuse (10 Amp) ECM/Injector/Ignition/Knock Module
18- Harness Connector To Starting/Charging Harness
19- Positive (+) Power Wire To Engine Circuit Breaker

MIE (Inboard) Models

THUNDERBOLT IV WITH IGNITION MODULE MOUNTED ON EXHAUST ELBOW



50773

NOTE: *Taped Back BROWN-WHITE wire may be used for an accessory. LOAD MUST NOT EXCEED 5 AMPS.*

A - Ignition And Choke System

1 - Distributor
2 - Ignition Module
3 - Ignition Coil

B - Starting And Charging System

1 - Alternator
2 - Ground Stud
3 - Battery
4 - Starter Motor
5 - Circuit Breaker
6 - Neutral Start Safety Switch
7 - Starter Slave Solenoid

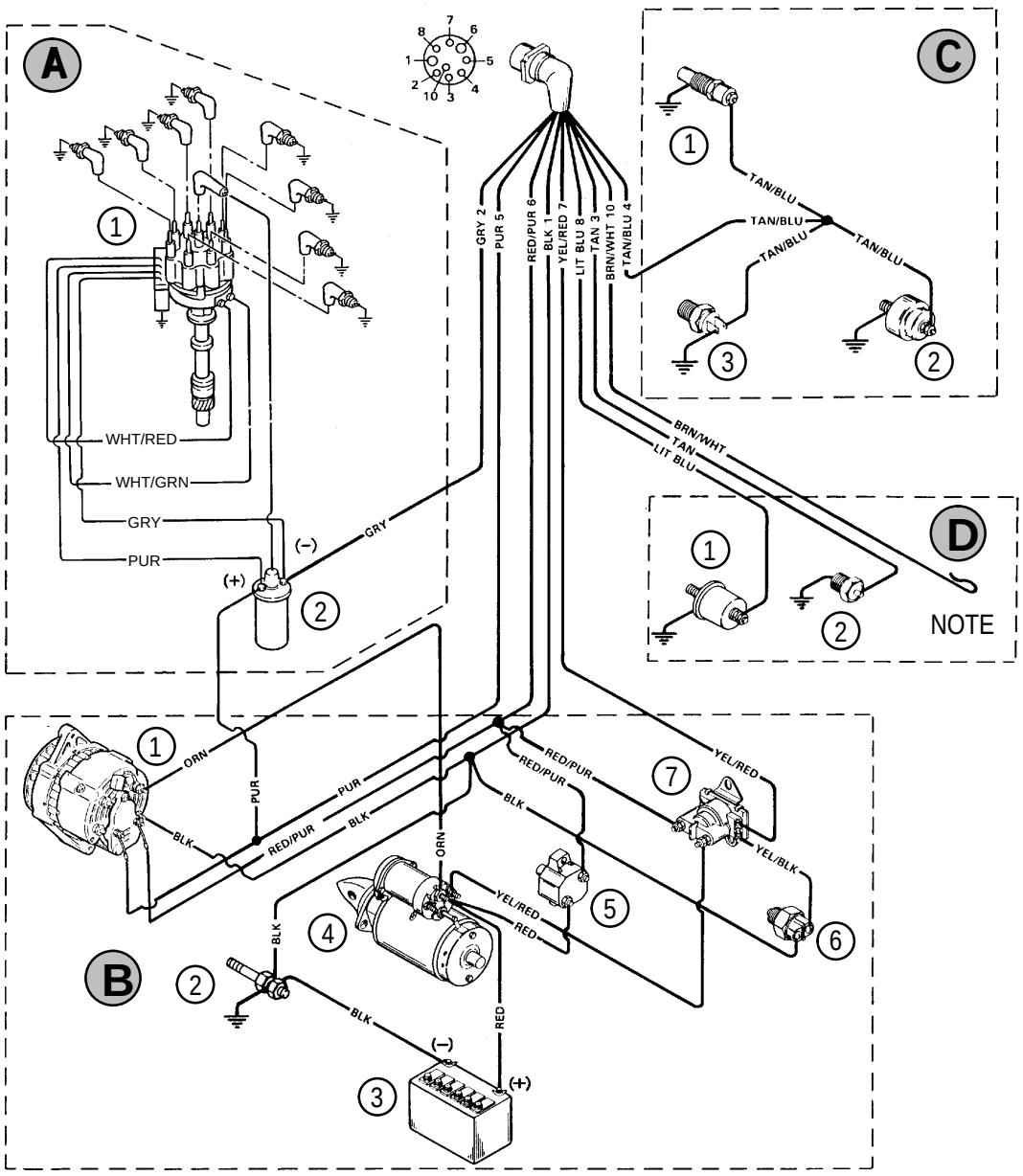
C - Audio Warning System

1 - Water Temperature
2 - Oil Pressure
3 - Transmission Fluid Temperature

D - Instrumentation System

1 - Oil Pressure Sender
2 - Water Temperature Sender

THUNDERBOLT IV IGNITION MODULE MOUNTED ON DISTRIBUTOR



NOTE: *Taped Back BROWN-WHITE wire may be used for an accessory. LOAD MUST NOT EXCEED 5 AMPS.*

A - Ignition And Choke System

1 - Distributor
2 - Ignition Module
3 - Ignition Coil

B - Starting And Charging System

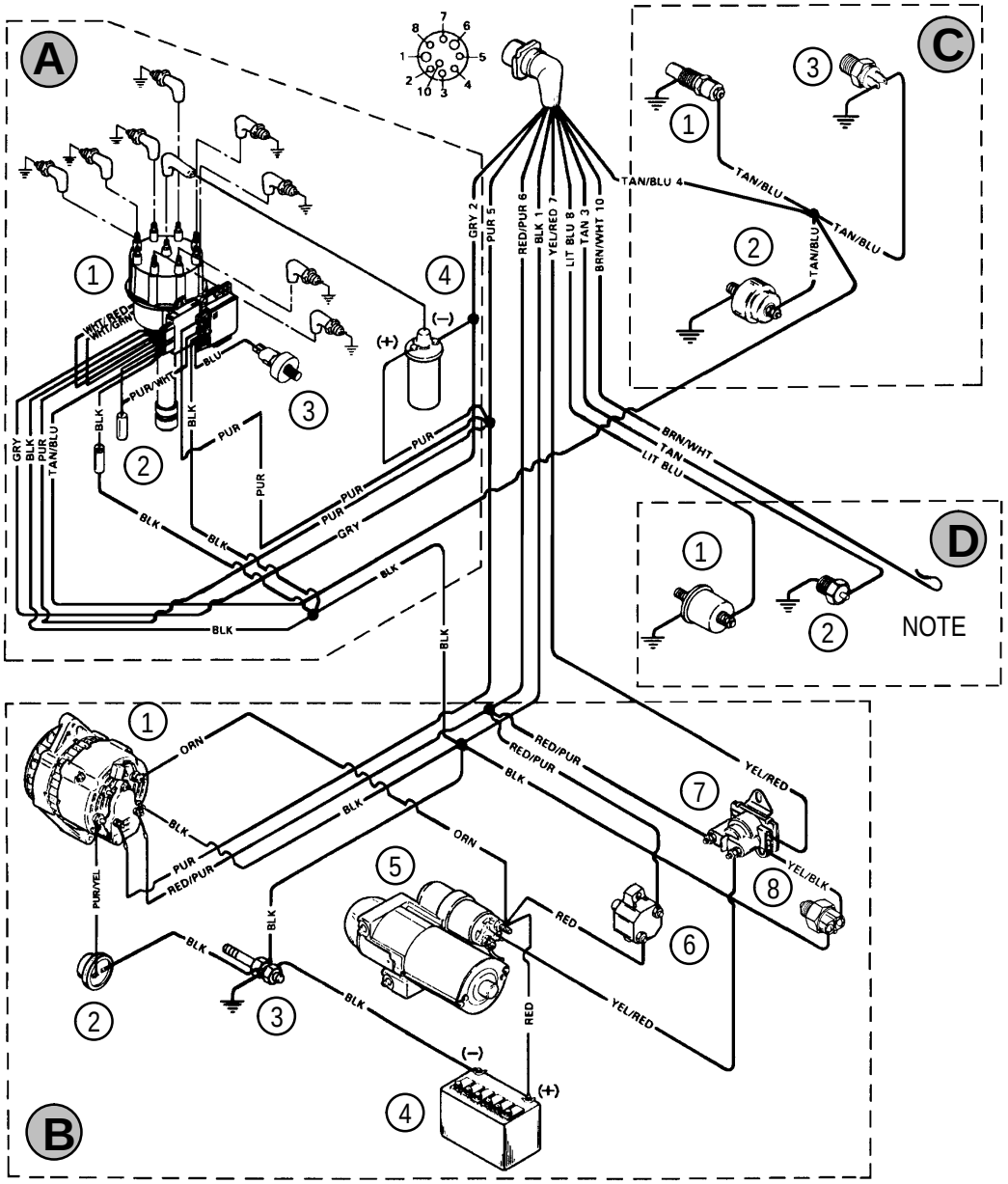
1 - Alternator
2 - Ground Stud
3 - Battery
4 - Starter Motor
5 - Circuit Breaker
6 - Neutral Start Safety Switch
7 - Starter Slave Solenoid

C - Audio Warning System

1 - Water Temperature
2 - Oil Pressure
3 - Transmission Fluid Temperature

D - Instrumentation System

1 - Oil Pressure Sender
2 - Water Temperature Sender



NOTE: *Taped Back BROWN-WHITE wire may be used for an accessory. LOAD MUST NOT EXCEED 5 AMPS.*

A - Ignition And Choke System

1 - Distributor With Ignition Module
2 - Timing Lead
3 - Knock Sensor
4 - Ignition Coil

B - Starting And Charging System

1 - Alternator
2 - Electric Choke
3 - Ground Stud
4 - Battery
5 - Starter Motor
6 - Circuit Breaker
7 - Starter Slave Solenoid
8 - Neutral Start Safety Switch

C - Audio Warning System

1 - Water Temperature Sender
2 - Oil Pressure Sender
3 - Transmission Fluid Temperature

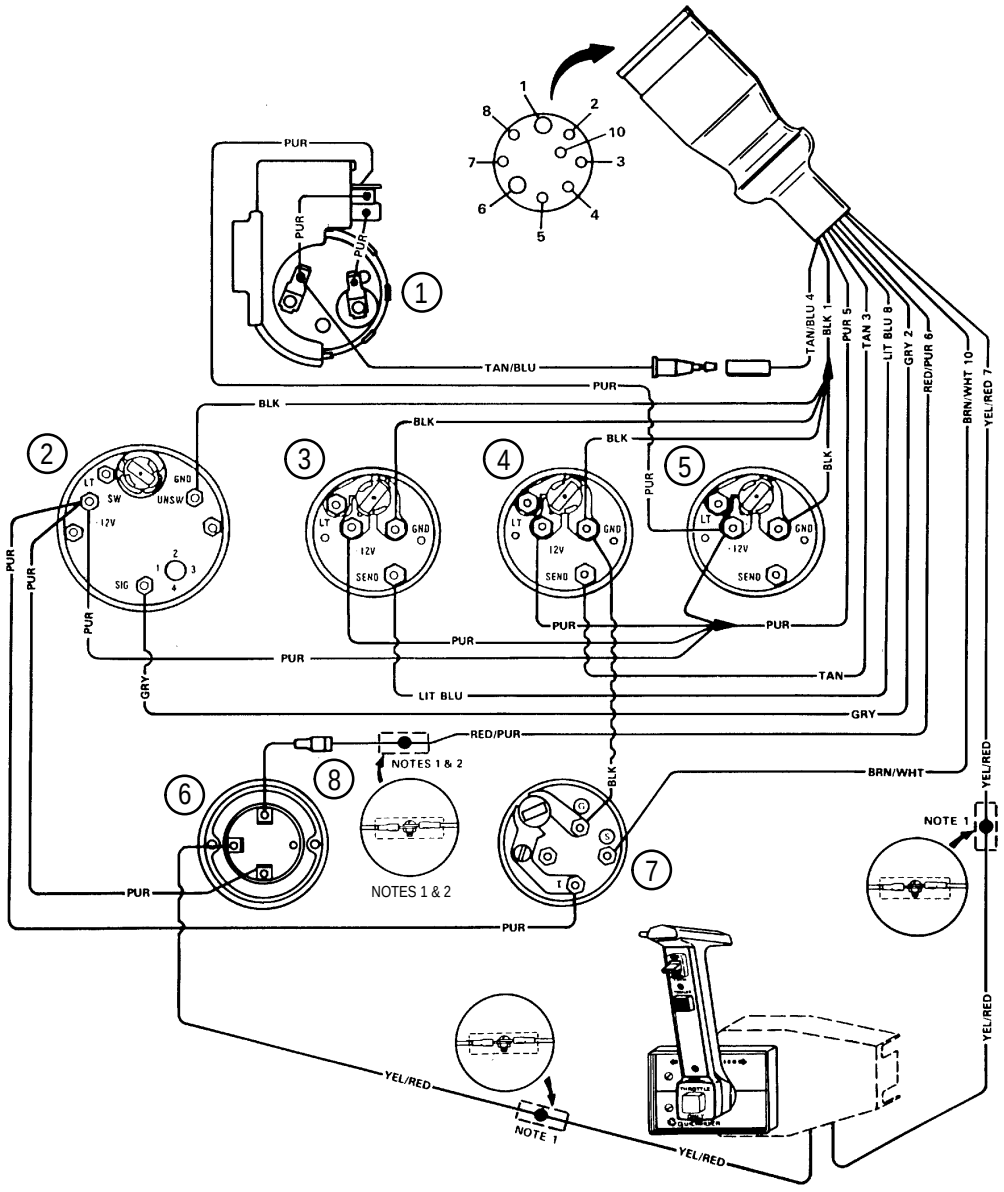
D - Instrumentation System

1 - Water Temperature
2 - Oil Pressure Switch

Quicksilver Instrumentation

MCM (Stern Drive)

EARLIER STYLE CONTROL AND AUDIO WARNING BUZZER



72938

Refer to gauge manufacturer's instructions for specific connections.

NOTE 1: Connect wires together with screw and hex nut. Apply Liquid Neoprene to connection and slide rubber sleeve over connection.

NOTE 2: Power for a fused accessory panel may be taken from this connection. Load MUST NOT exceed 35-40 amps. Panel ground wire MUST BE connected to instrument terminal that has an 8 gauge BLACK (Ground) harness wire connected to it.

1 - Audio Warning Buzzer (If So Equipped)
2 - Tachometer
3 - Oil Pressure
4 - Water Temperature
5 - Battery Meter
6 - Ignition Switch
7 - Trim Indicator
8 - 20 Amp. Fuse

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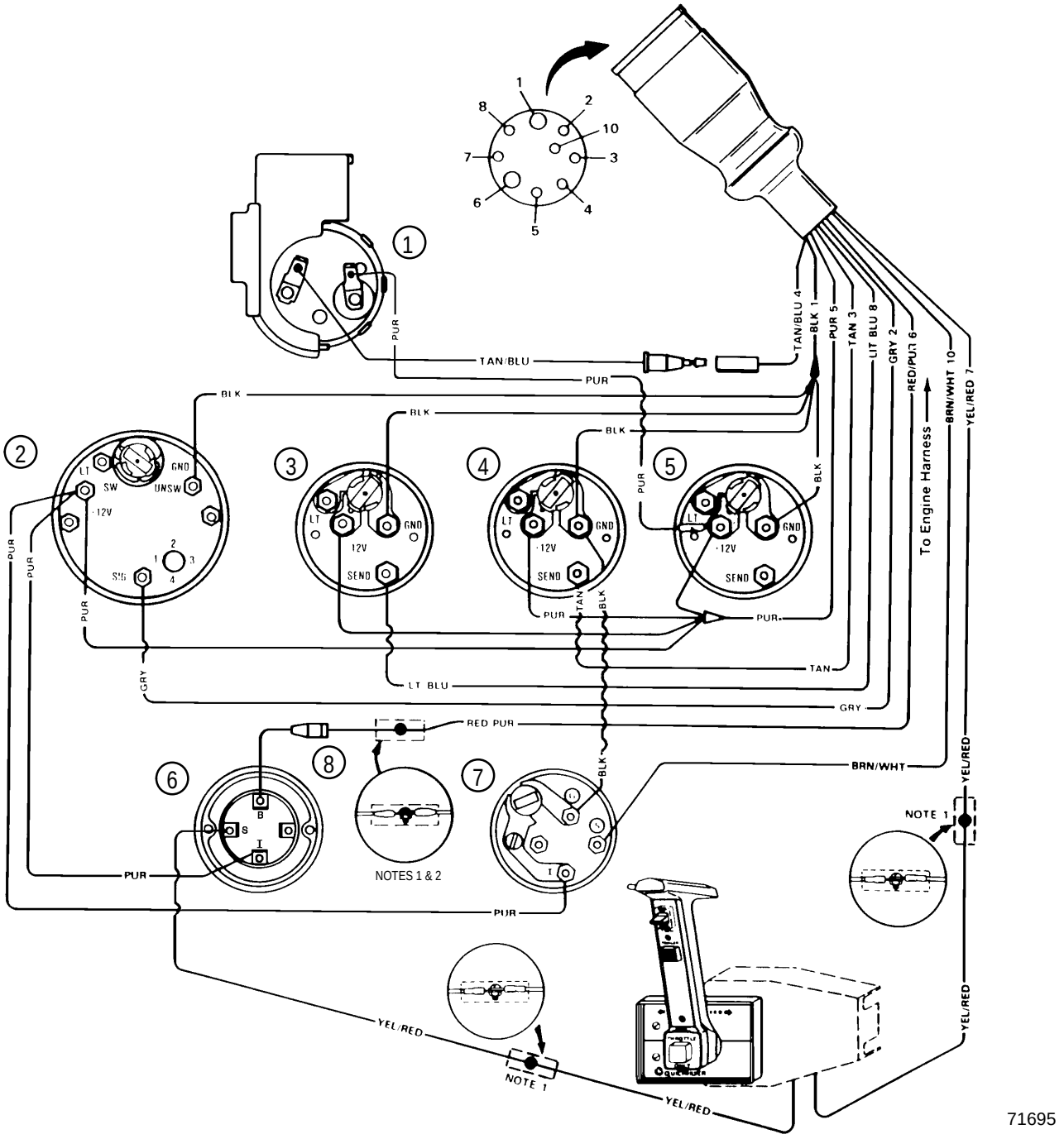
454/502 MAGNUM MULTI-PORT INJECTION WITH EARLIER STYLE CONTROLS AND AUDIO WARNING BUZZER



Refer to gauge manufacturer's instructions for specific connections.

NOTE 1: Connect wires together with screw and hex nut. Apply Liquid Neoprene to connection and slide rubber sleeve over connection.

NOTE 2: Power for a fused accessory panel may be taken from this connection. Load MUST NOT exceed 40 amps. Panel ground wire MUST BE connected to instrument terminal that has an 8 gauge BLACK (Ground) harness wire connected to it.

1 - Audio Warning Buzzer (If Equipped)
2 - Tachometer
3 - Oil Pressure
4 - Water Temperature
5 - Battery Meter
6 - Ignition Switch
7 - Trim Indicator
8 - 20 Amp. Fuse

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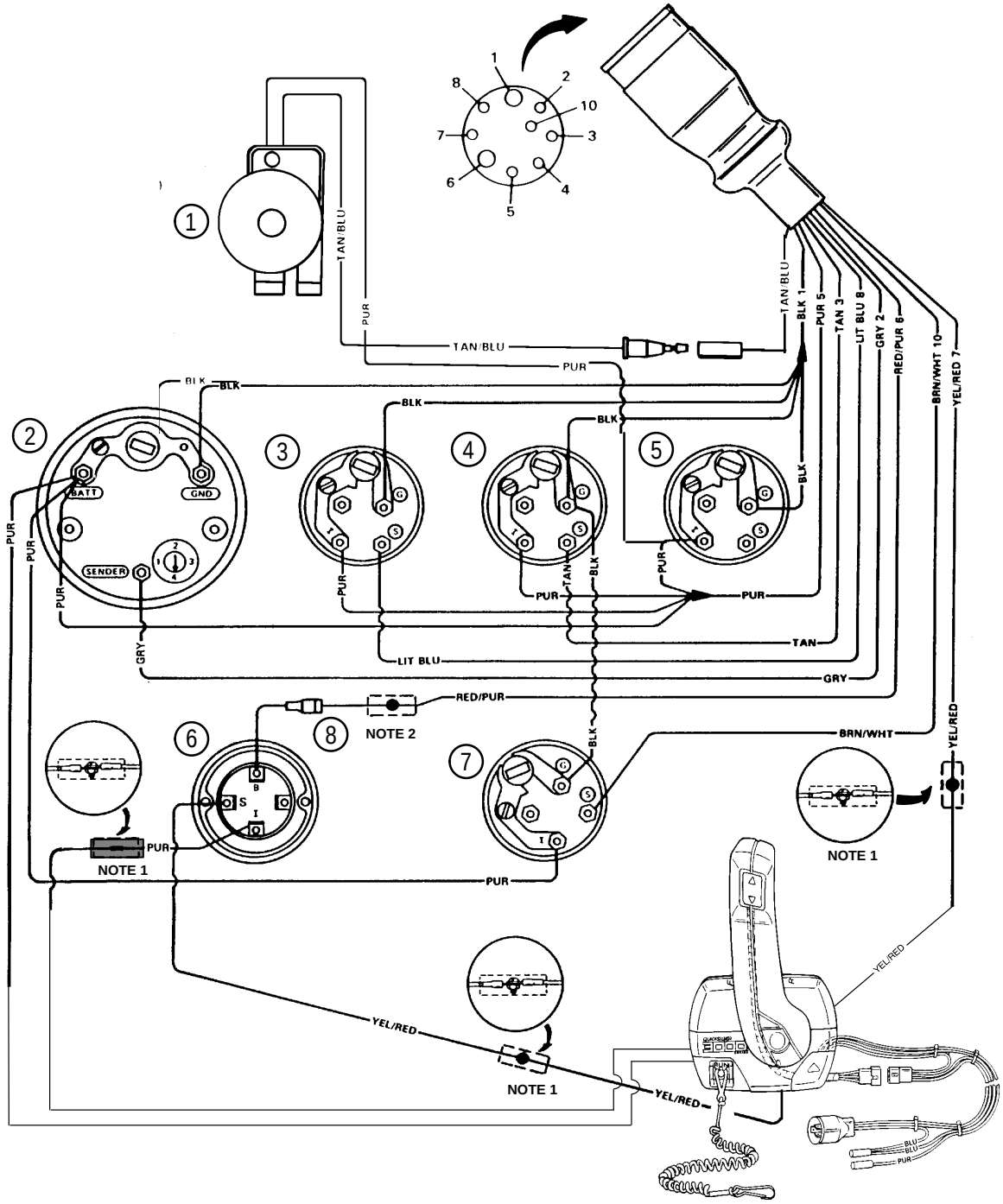
LATER STYLE CONTROLS AND AUDIO WARNING BUZZER



74046

Refer to gauge manufacturer's instructions for specific connections.

NOTE 1: Connect wires together with screw and hex nut. Apply Liquid Neoprene to connection and slide rubber sleeve over connection.

NOTE 2: Power for a fused accessory panel may be taken from this connection. Load MUST NOT exceed 40 amps. Panel ground wire MUST BE connected to instrument terminal that has an 8 gauge BLACK (Ground) harness wire connected to it.

1 - Audio Warning Buzzer (If Equipped)
2 - Tachometer
3 - Oil Pressure
4 - Water Temperature
5 - Battery Meter
6 - Ignition Switch
7 - Trim Indicator
8 - 20 Amp. Fuse

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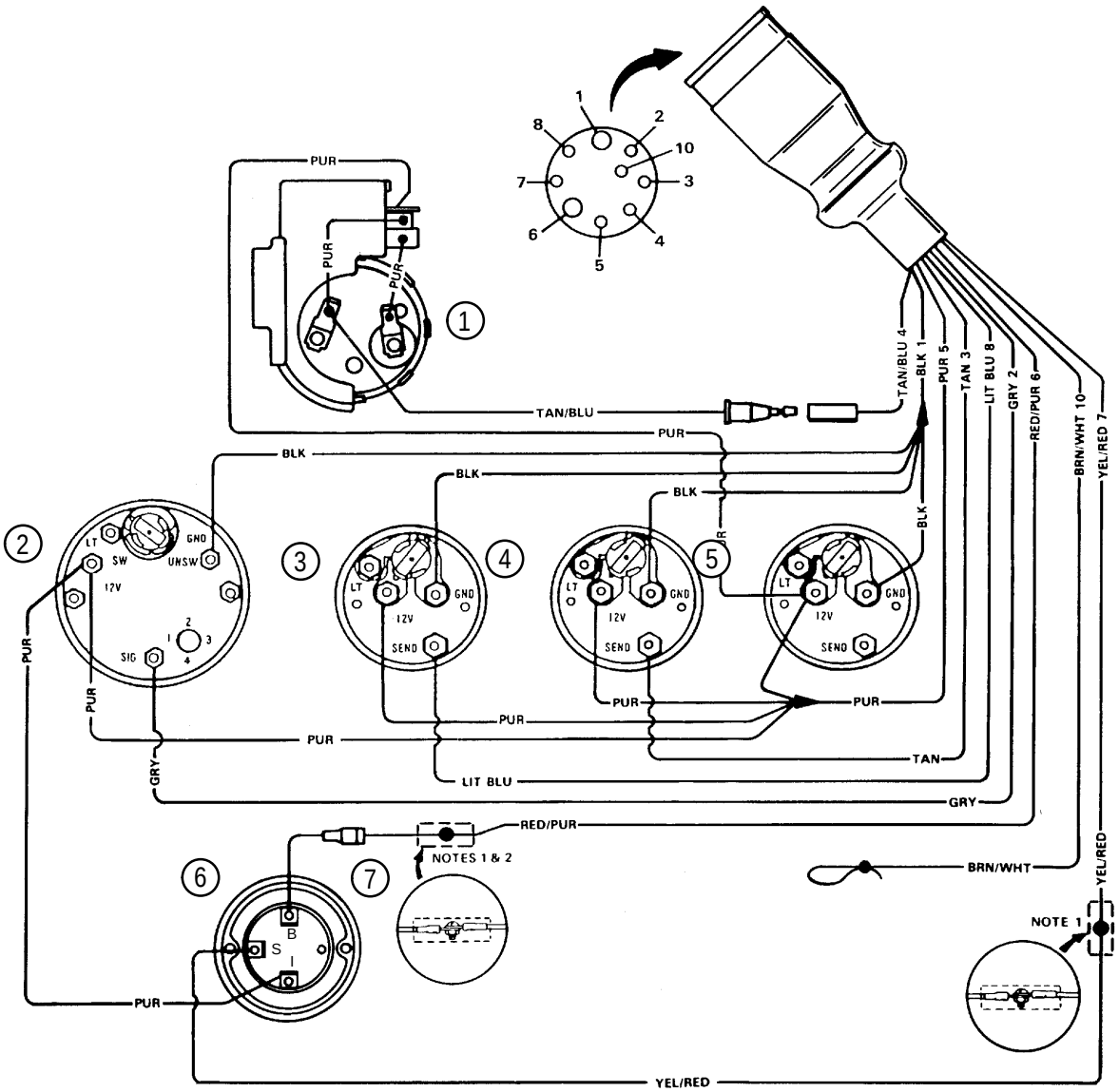
MIE (Inboard)

EARLIER STYLE AUDIO WARNING BUZZER



72939

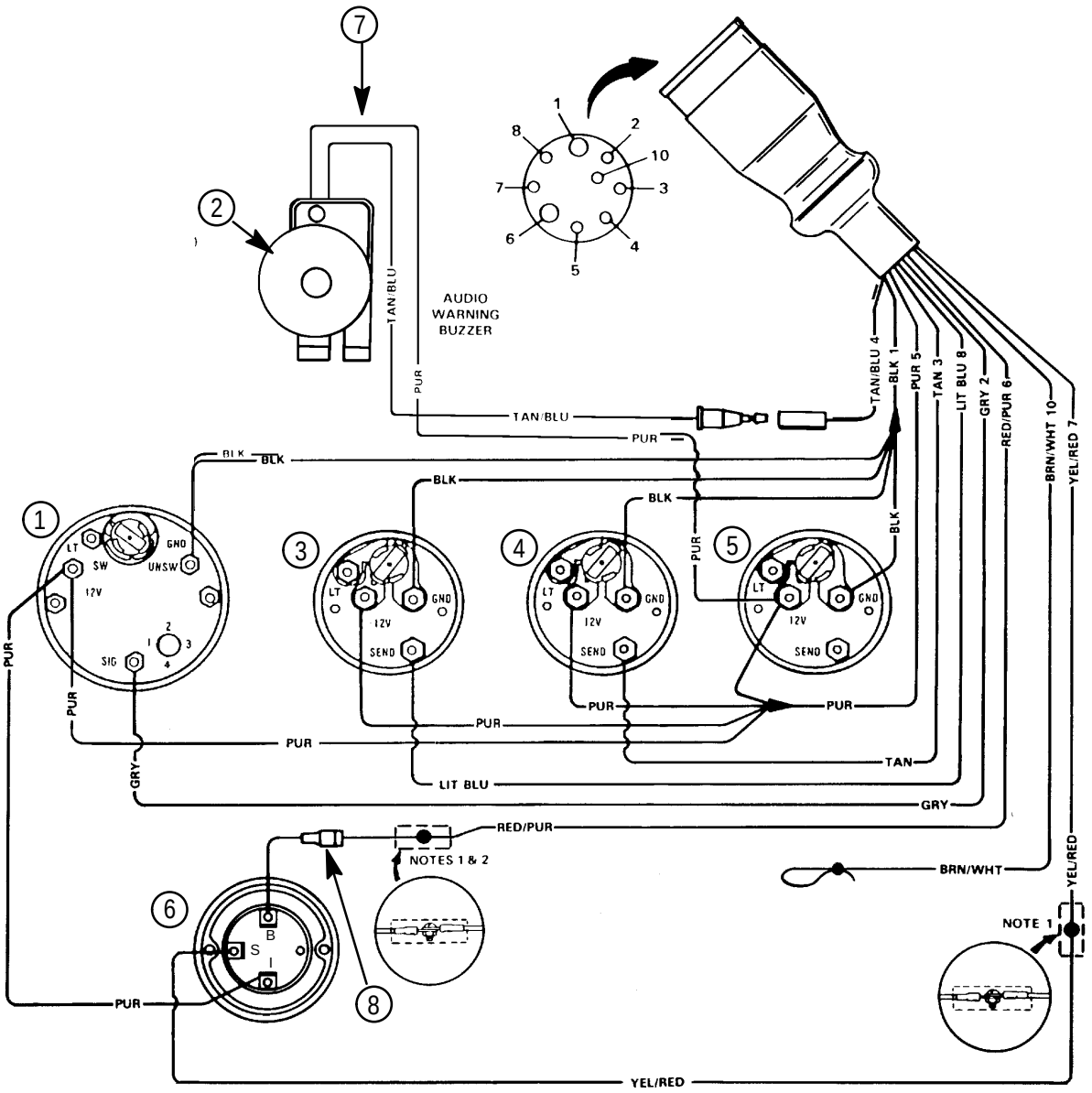
Refer to gauge manufacturer's instructions for specific connections.

NOTE 1: Connect wires together with screw and hex nut. Apply Liquid Neoprene to connection and slide rubber sleeve over connection.

NOTE 2: Power for a fused accessory panel may be taken from this connection. Load MUST NOT exceed 40 amps. Panel ground wire MUST BE connected to instrument terminal that has an 8 gauge BLACK (Ground) harness wire connected to it.

1 - Audio Warning Buzzer (If So Equipped)
2 - Tachometer
3 - Oil Pressure
4 - Water Temperature
5 - Battery Meter
6 - Ignition Switch
7 - 20 Amp. Fuse

LATER STYLE AUDIO WARNING BUZZER



74274

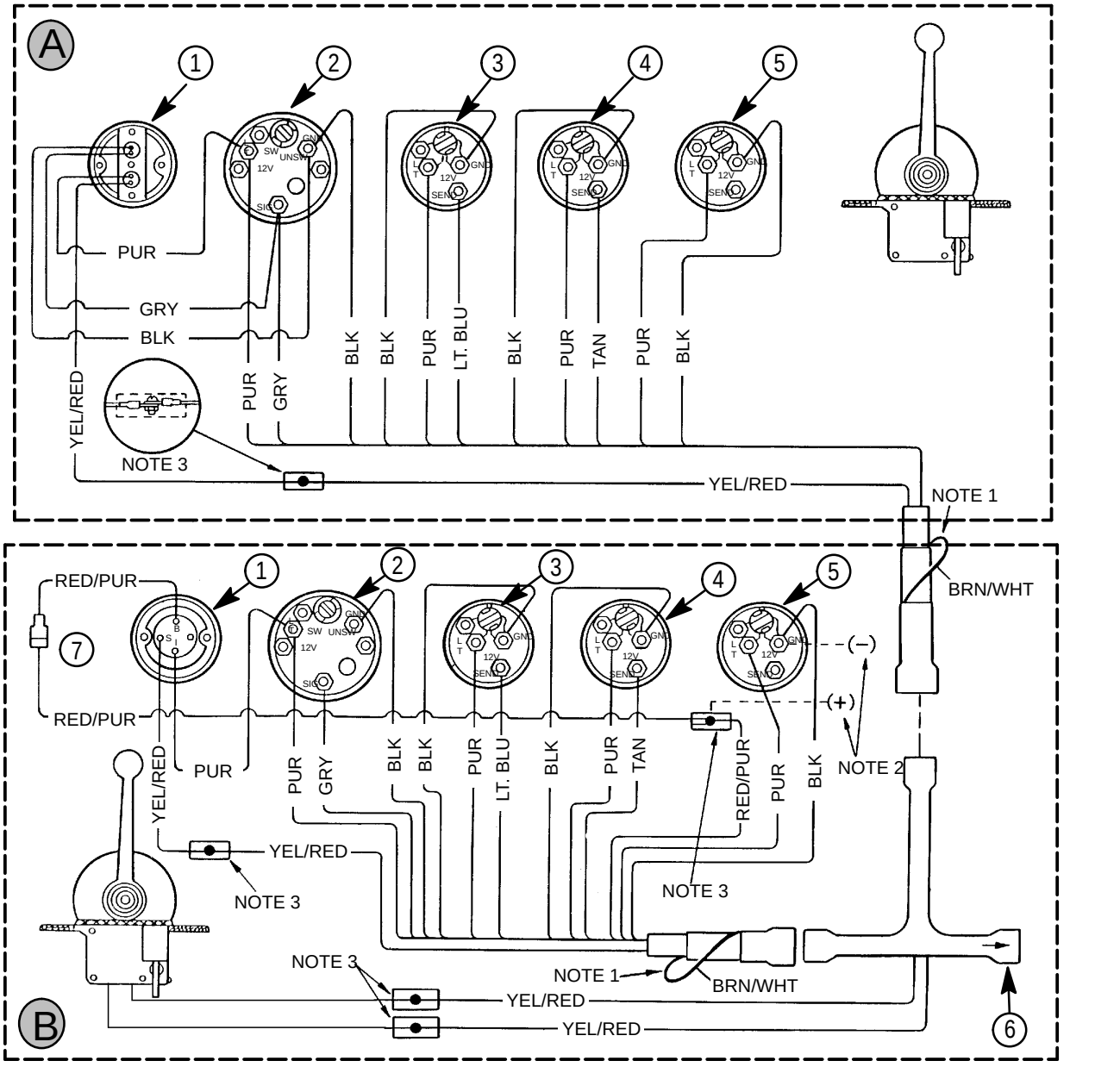
Refer to gauge manufacturer's instructions for specific connections.

NOTE 1: Connect wires together with screw and hex nut. Apply Quicksilver Liquid Neoprene to connection and slide rubber sleeve over connection.

NOTE 2: Power for a second fused accessory panel may be taken from this connection. Load **MUST NOT** exceed 35-40 amps. Panel ground wire **MUST BE** connected to instrument terminal that has an 8 gauge BLACK (ground) harness wire connected to it.

1 - Audio Warning Buzzer (If So Equipped)
2 - Tachometer
3 - Oil Pressure
4 - Water Temperature
5 - Battery Meter
6 - Ignition Switch
7 - To 12 Volt Source (PURPLE Wire Connection)
8 - 20 Amp. Fuse

Dual Station Wiring (Using a Neutral Safety Switch in Only One Remote Control)



72940

NOTE 1: BROWN/WHITE wire is taped back at instrument end. If installing on boat that is equipped with MerCruiser stern drive, BROWN/WHITE wire is connected to trim sender terminal block. If installing on MerCruiser Inboard, BROWN/WHITE wire is taped back at engine end, or it may be used for an accessory (limit 5 amperes).

NOTE 2 : An accessory fuse panel may be connected at this location. The combined current draw of the primary station and secondary station **MUST NOT** exceed 35 amperes.

NOTE 3 : Connect wires together with screw and hex nut. Apply Quicksilver Liquid Neoprene to connection and slide rubber sleeve over connection.

B - Secondary Station

1 - Start - Stop Panel
2 - Tachometer
3 - Oil Pressure
4 - Water Temperature
5 - Battery Meter

B - Primary Station

1 - Ignition Switch
2 - Tachometer
3 - Oil Pressure
4 - Water Temperature
5 - Battery Meter

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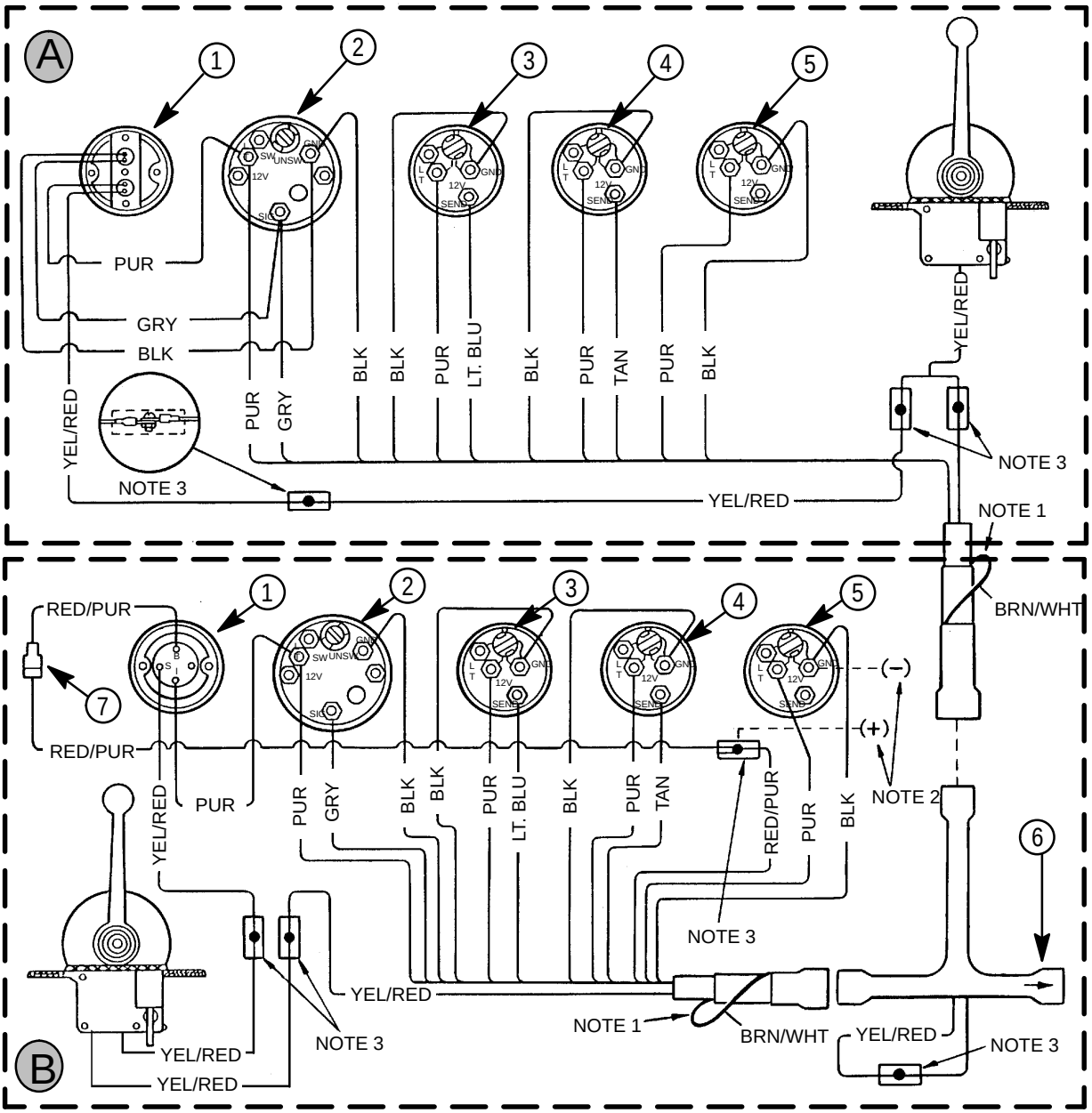
Dual Station Wiring (Using A Neutral Safety Switch In Both Remote Controls)



72941

NOTE 1: BROWN/WHITE wire is taped back at instrument end. If installing on boat that is equipped with MerCruiser stern drive, BROWN/WHITE wire is connected to trim sender terminal block. If installing on MerCruiser Inboard, BROWN/WHITE wire is taped back at engine end, or it may be used for an accessory (limit 5 amperes).

NOTE 2 : An accessory fuse panel may be connected at this location. The combined current draw of the primary station and secondary station **MUST NOT** exceed 35 amperes.

NOTE 3 : Connect wires together with screw and hex nut. Apply Quicksilver Liquid Neoprene to connection and slide rubber sleeve over connection.

A - Secondary Station

1 - Start - Stop Panel
2 - Tachometer
3 - Oil Pressure
4 - Water Temperature
5 - Battery Meter

B - Primary Station

1 - Ignition Switch
2 - Tachometer
3 - Oil Pressure
4 - Water Temperature
5 - Battery Meter
6 - To Engine
7 - 20 Ampere Fuse

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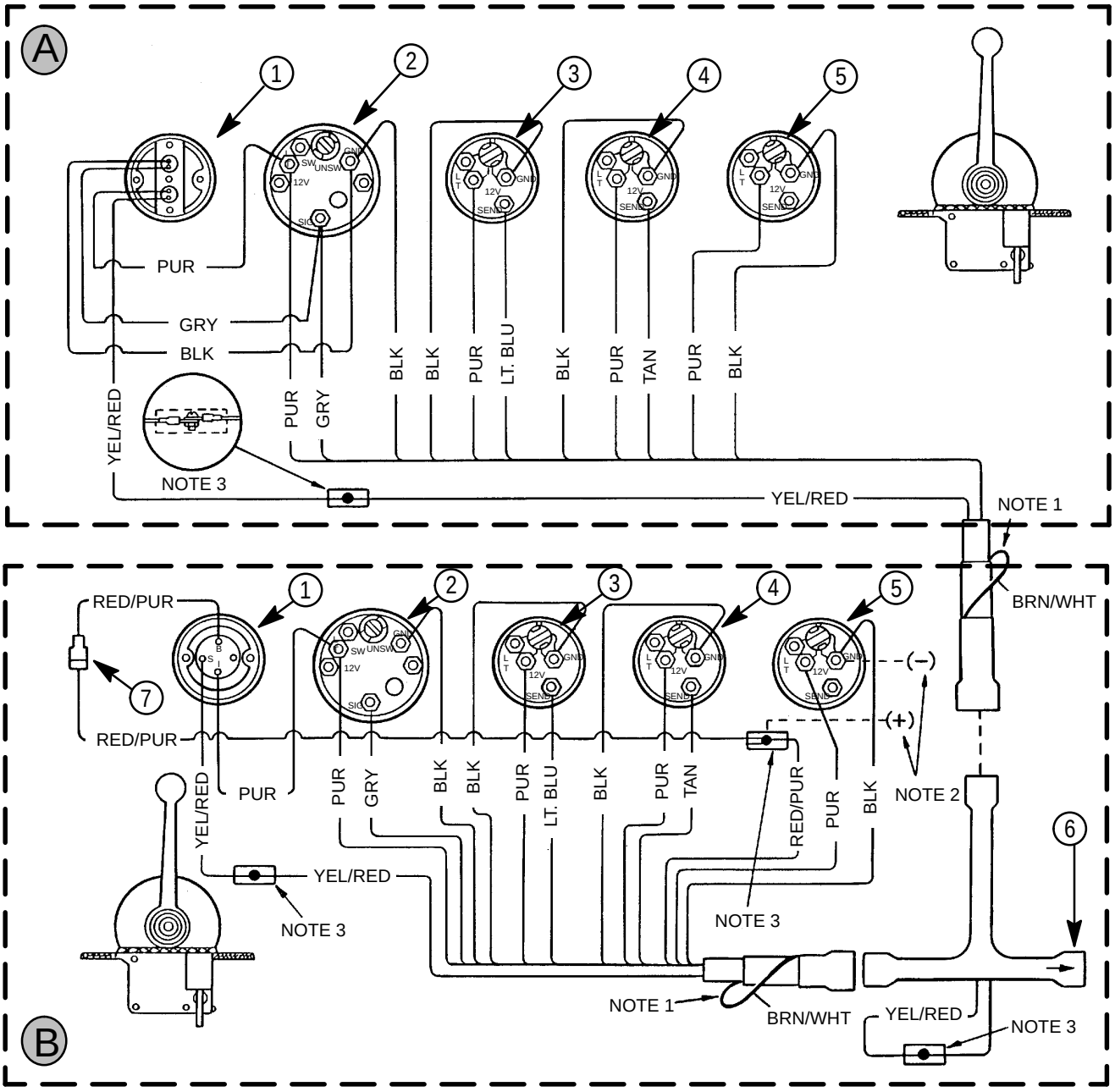
Dual Station Wiring (Using a Neutral Safety Switch in Engine Wiring Harness)



NOTE 1: BROWN/WHITE wire is taped back at instrument end. If installing on boat that is equipped with Mer-Cruiser stern drive, BROWN/WHITE wire is connected to trim sender terminal block. If installing on MerCruiser Inboard, BROWN/WHITE wire is taped back at engine end, or it may be used for an accessory (limit 5 amperes).

NOTE 2 : An accessory fuse panel may be connected at this location. The combined current draw of the primary station and secondary station **MUST NOT** exceed 35 amperes.

NOTE 3 : Connect wires together with screw and hex nut. Apply Quicksilver Liquid Neoprene to connection and slide rubber sleeve over connection.

A - Secondary Station

1 - Start - Stop Panel
2 - Tachometer
3 - Oil Pressure
4 - Water Temperature
5 - Battery Meter

B - Primary Station

1 - Ignition Switch
2 - Tachometer
3 - Oil Pressure
4 - Water Temperature
5 - Battery Meter
6 - To Engine
7 - 20 Ampere Fuse

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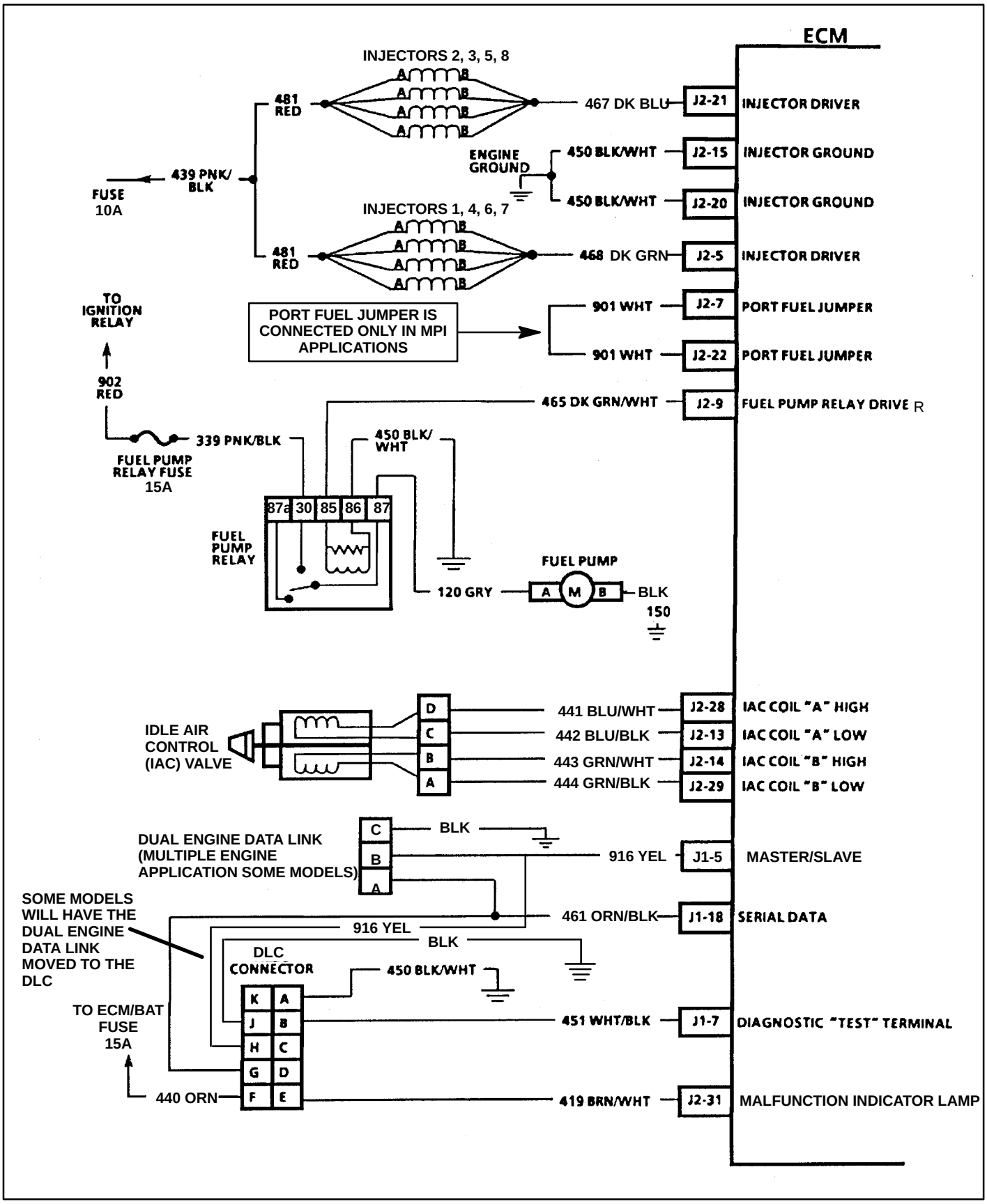
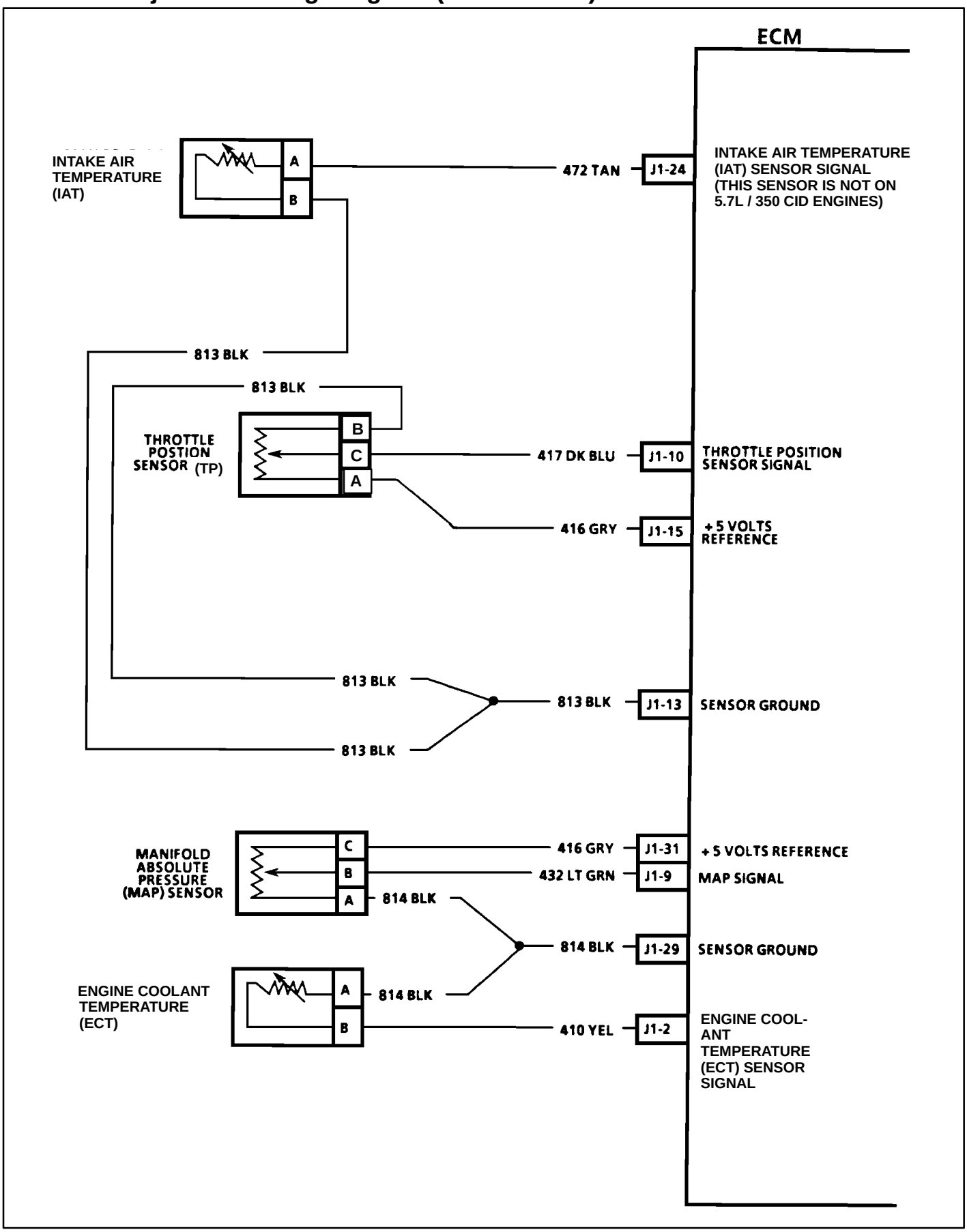
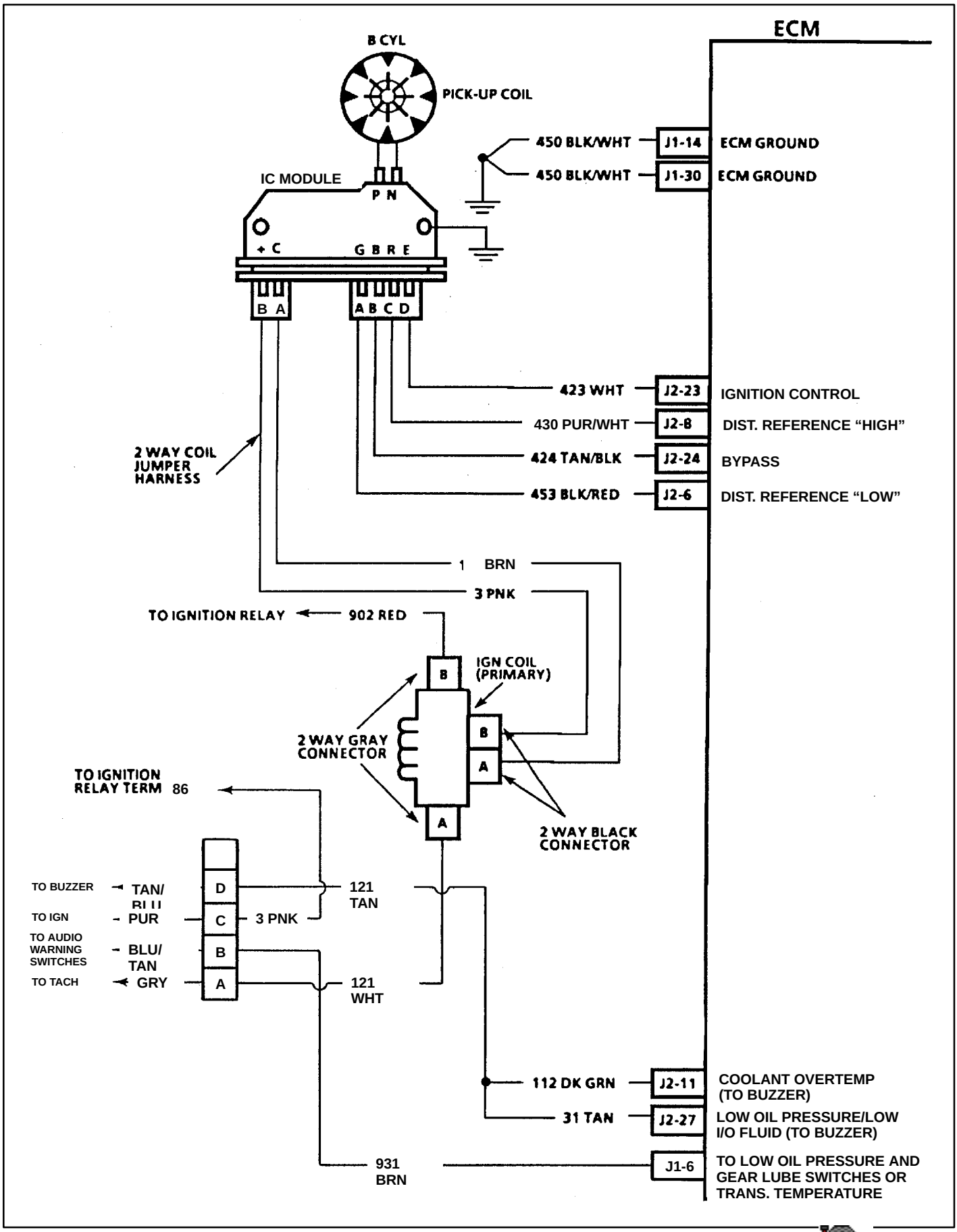
Multi-Port Injection Wiring Diagram (Chart 1 Of 4)



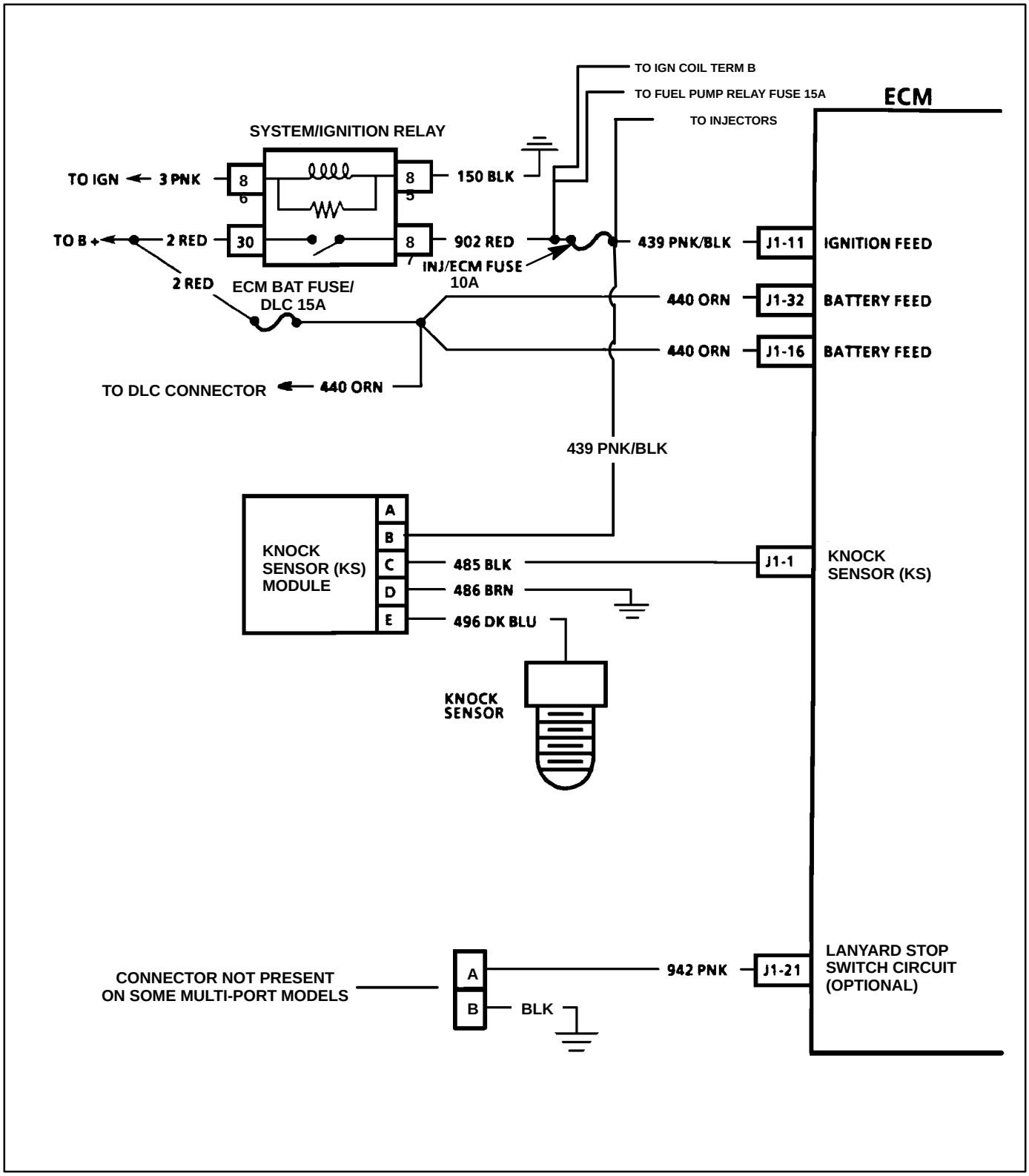
Multi-Port Injection Wiring Diagram (Chart 2 Of 4)



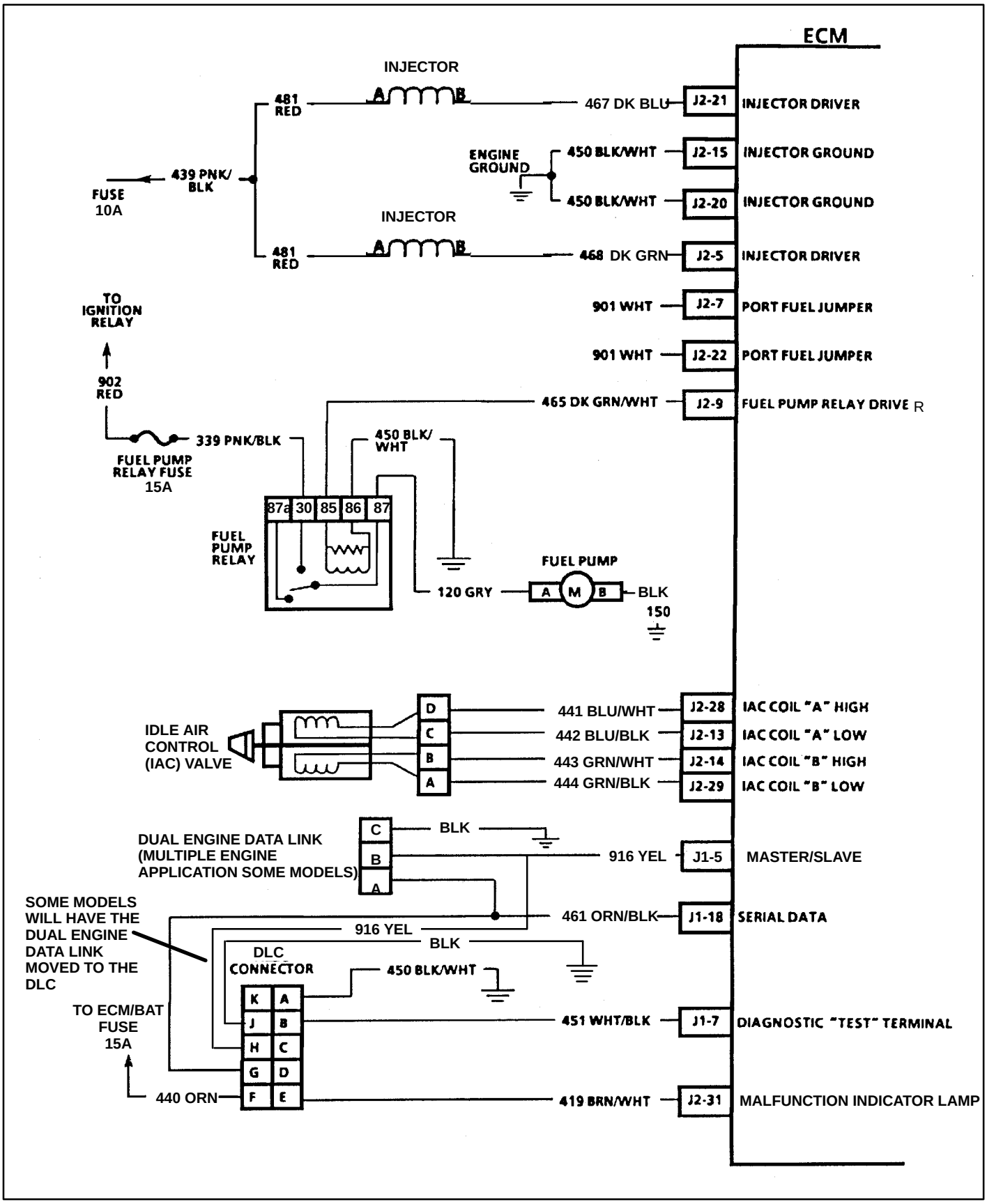
Multi-Port Injection Wiring Diagram (Chart 3 Of 4)



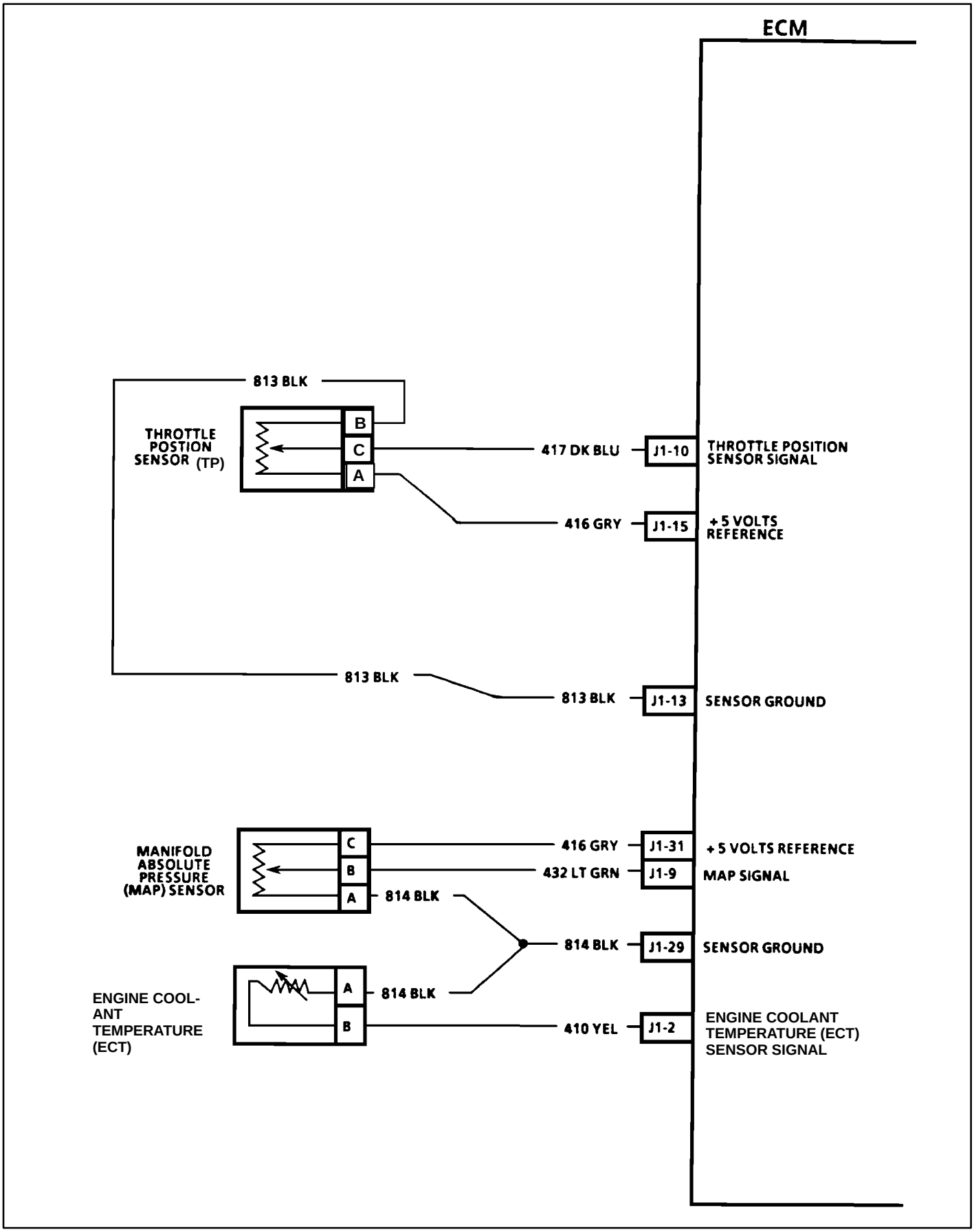
Multi-Port Injection Wiring Diagram (Chart 4 Of 4)



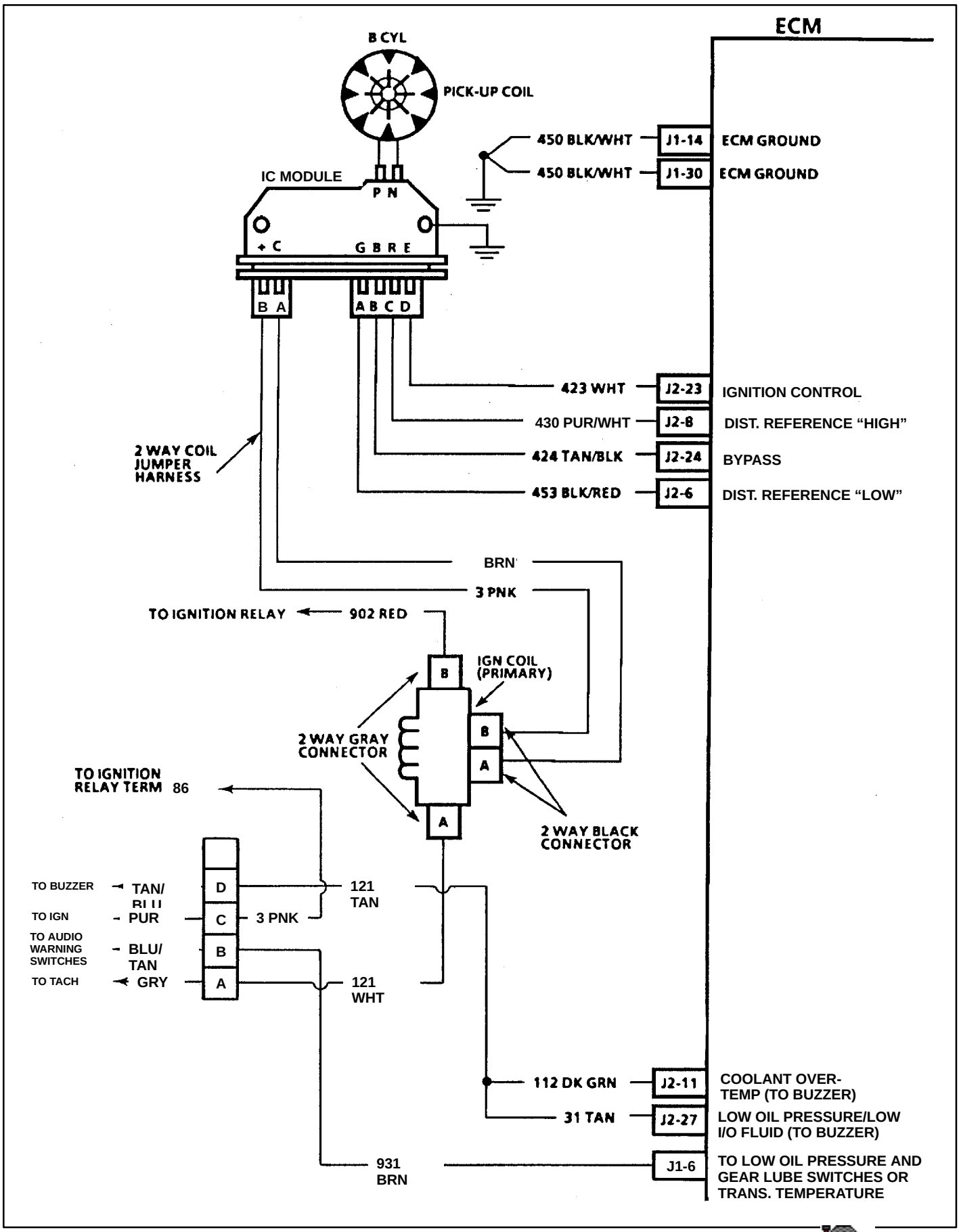
Throttle Body Injection Wiring Diagram (Chart 1 Of 4)



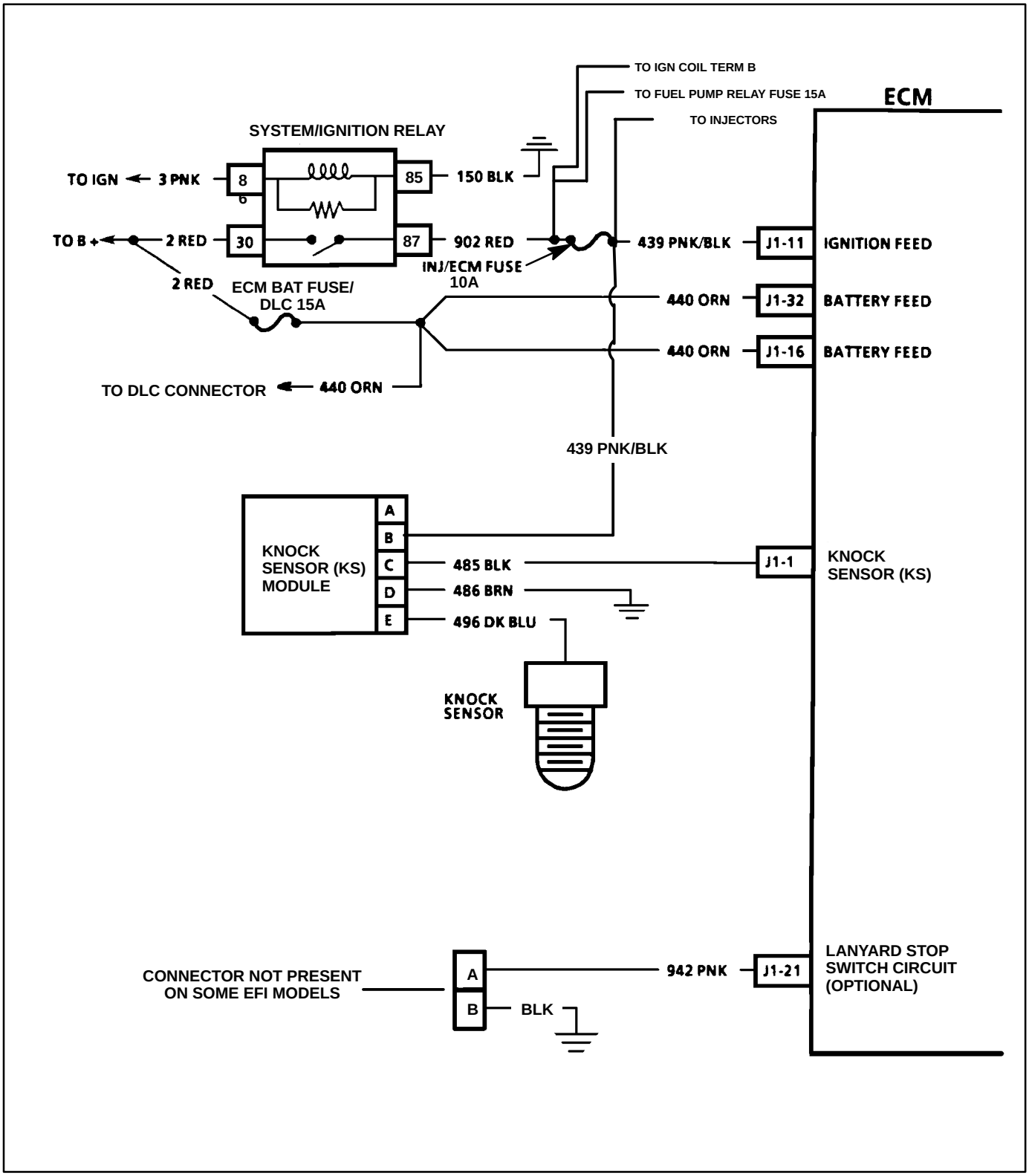
Throttle Body Injection Wiring Diagram (Chart 2 Of 4)



Throttle Body Injection Wiring Diagram (Chart 3 Of 4)



Throttle Body Injection Wiring Diagram (Chart 4 Of 4)



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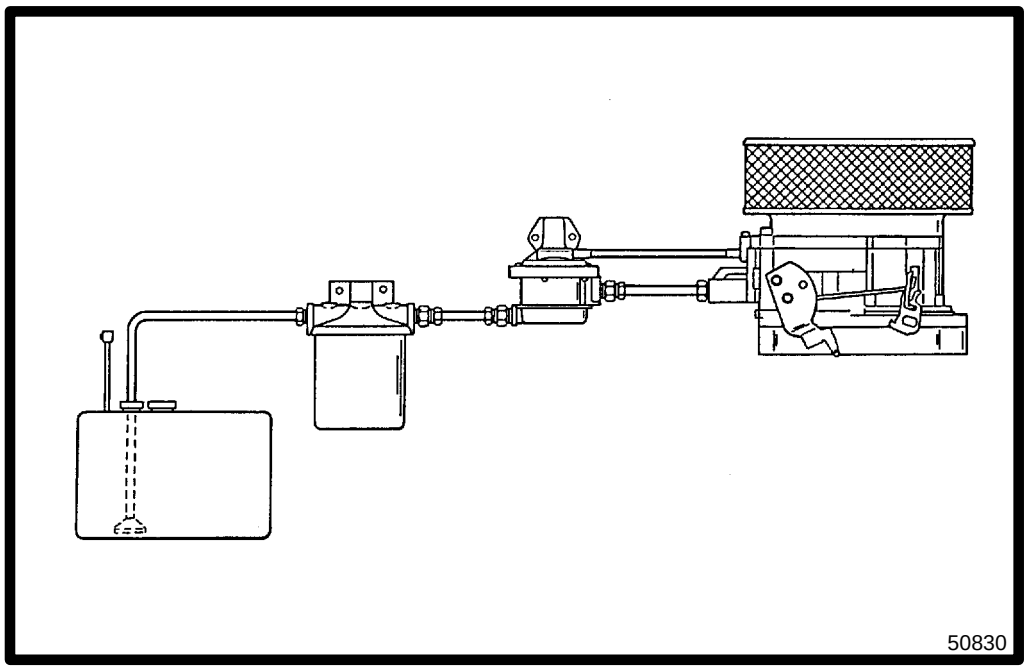
THIS PAGE IS INTENTIONALLY BLANK TO ALLOW FOR CORRECTIONS OR ADDITIONS AT A LATER DATE

FUEL SYSTEM



5

A

FUEL DELIVERY SYSTEMS AND FUEL PUMPS

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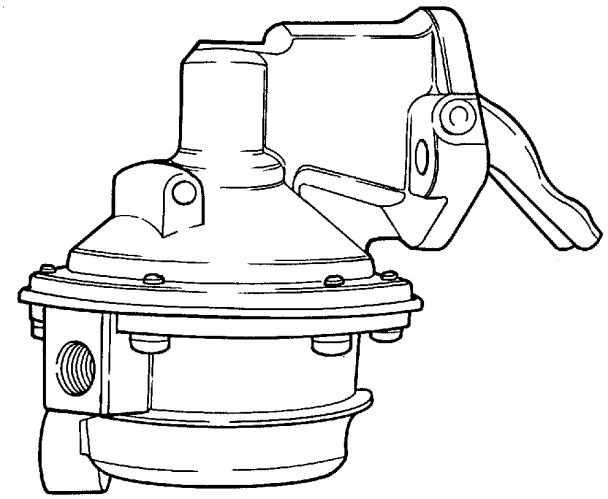
NOTICE

For information and procedures on trouble-shooting, refer to Section 1C.

Identification



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Replacement Parts Warning

⚠ WARNING

Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

Torque Specifications

Fastener Location	lb. ft.	N·m
Fuel Pump To Seawater Pickup Pump	25	34
Fuel Lines	18	24
Fuel Fittings	See Note	

NOTE: *Refer To "Fuel Supply Connections" Warning following this chart.*

Fuel Supply Connections

⚠ WARNING

Avoid gasoline fire or explosion. Improper installation of brass fittings or plugs into fuel pump or fuel filter base can crack casting and/or cause a fuel leak.

- **Apply #592 Loctite Pipe Sealant with Teflon to threads of brass fitting or plug. DO NOT USE TEFLON TAPE.**
- **Thread brass fitting or plug into fuel pump or fuel filter base until finger tight.**
- **Tighten fitting or plug an additional 1-3/4 to 2-1/4 turns using a wrench. DO NOT OVER-TIGHTEN.**
- **Install fuel line. To prevent over-tightening, hold brass fitting with suitable wrench and tighten fuel line connectors securely.**
- **Check for fuel leaks.**

Tools / Lubricants / Sealants

Description	Part Number
Fuel Pressure Connector (Carburetor)	91-18078
Quicksilver Perfect Seal	92-34227--1
#592 Loctite Pipe Sealant with Teflon	Obtain Locally
Fuel Pressure Gauge	

Specifications

Description	Specification
Pump Pressure	3-8 PSI (21-48 kPa)

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Precautions

⚠WARNING

Always disconnect battery cables from battery BEFORE working on fuel system to prevent fire or explosion.

⚠WARNING

Be careful when changing fuel system components; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark or flame in the area while changing fuel filters. Wipe up any spilled fuel immediately.

⚠WARNING

Make sure that no fuel leaks exist before closing engine hatch.

⚠CAUTION

DO NOT operate engine without cooling water being supplied to seawater pickup pump, or pump impeller will be damaged and subsequent overheating damage may result.

Fuel Delivery System

Recommendations

⚠WARNING

Boating industry standards (BIA, ABYC, etc.) federal standards and Coast Guard regulations MUST BE adhered to when installing fuel delivery system.

When designing and installing fuel delivery system, the following information MUST BE observed:

1. Fuel tank should be mounted below carburetor level, if possible. If tank is mounted above carburetor level, gravity feed may cause carburetor fuel inlet needle to unseat, and flooding may result.
2. Fuel pickup should be at least 1 in. (25 mm) from the bottom of the fuel tank to prevent picking up water or other impurities.
3. Fuel lines used MUST BE Coast Guard approved (USCG type A) and MUST NOT BE SMALLER THAN 3/8 in. (9.5 mm) I.D. On installations where long lines or numerous fittings are required, larger size lines should be used.
4. Fuel line should be installed free of stress and firmly secured to prevent vibration and/or chafing.
5. Sharp bends in fuel line should be avoided.
6. A flexible fuel line must be used to connect fuel line to engine to absorb deflection when engine is running.

Fuel System Components

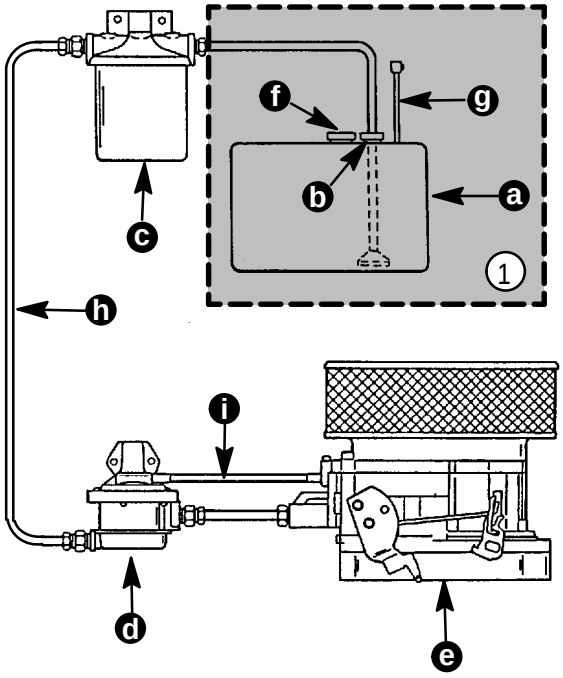
Description

The fuel system consists of fuel tank(s), a water separating fuel filter, a fuel pump and a carburetor.

The fuel is stored in the fuel tank. When the engine is cranking or running, fuel is drawn from the fuel tank, through the water separating filter, by a mechanically operated fuel pump. The fuel pump is operated by the seawater pump shaft cam rotation.

The fuel is pushed through the fuel line to the carburetor where it is metered and supplied to the engine.

Weber 4 Barrel Carburetor

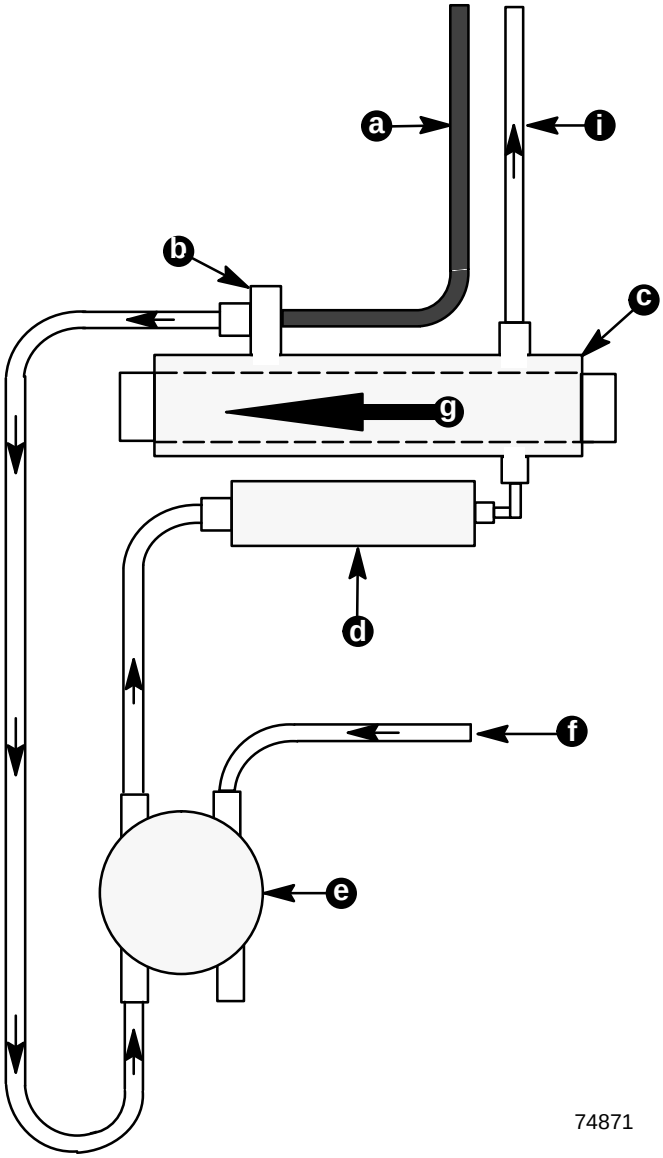


50830

a - Fuel Tank
b - Anti-Siphon Valve
c - Water Separating Fuel Filter
d - Fuel Pump
e - Carburetor
f - Fuel Filter
g - Vent Hose
h - Fuel Line
i - Sight Tube

1 - Boat Fuel System

Cool Fuel System



74871

a - Vacuum Line To Throttle Body
b - Fuel Pressure Regulator
c - Fuel Cooler
d - Electric Fuel Pump
e - Water Separating Fuel Filter
f - Fuel From Tank
g - Direction Of Water Flow
h - Throttle Body Unit
i - Fuel Line To Throttle Body
j - Excess Fuel Return To Water Separating Fuel Filter

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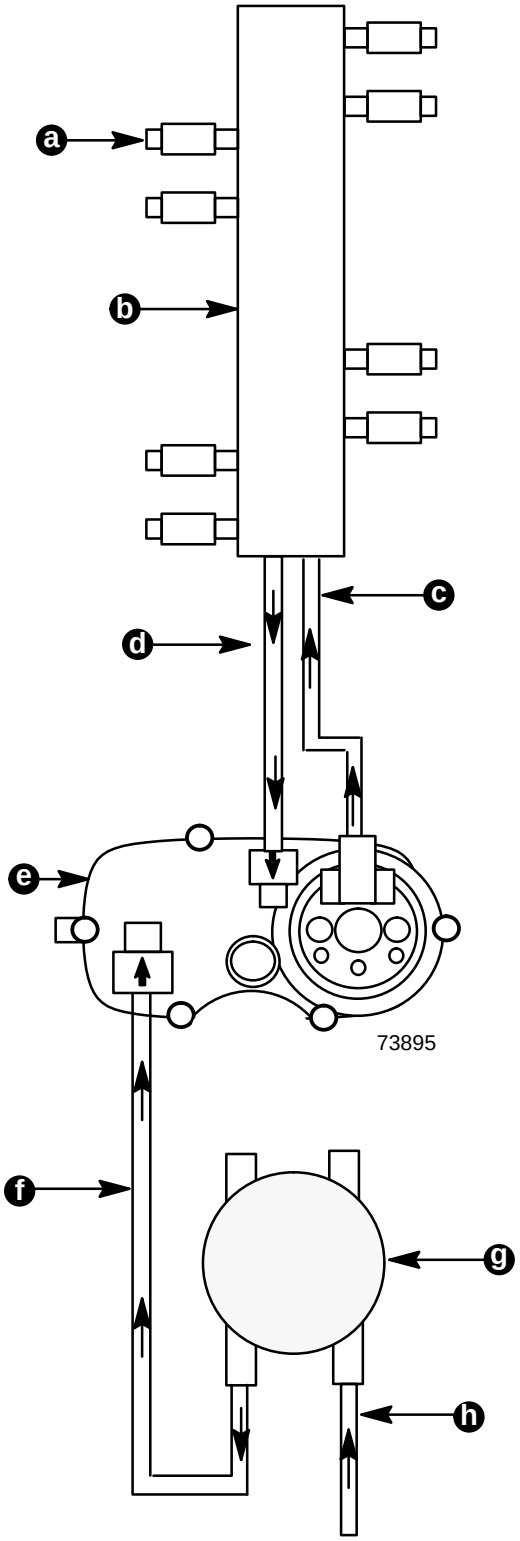
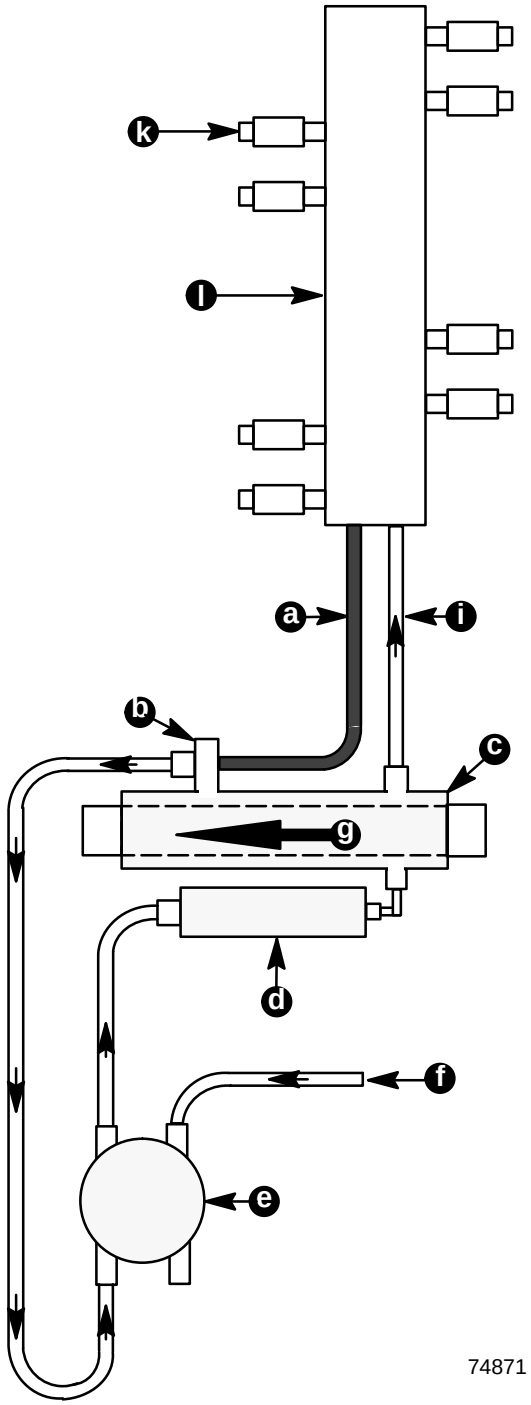
Multi-Port Injection With Vapor Separator Tank (VST)



a - Fuel Injector (8)
b - Fuel Rail
c - Outlet Fuel Line
d - Return Fuel Line
e - Vapor Separator Tank (VST)
f - Fuel Line From Water Separating Fuel Filter
g - Water Separating Fuel Filter
h - Fuel Line From Tank

Multi-Port Injection With Cool Fuel System



a - Vacuum Line To Throttle Body (Multi-Port) or Flame Arrestor (Throttle Body)
b - Fuel Pressure Regulator
c - Fuel Cooler
d - Electric Fuel Pump
e - Water Separating Fuel Filter
f - Fuel From Tank
g - Direction Of Water Flow
h - Throttle Body Unit
i - Fuel Line To Throttle Body
j - Excess Fuel Return To Water Separating Fuel Filter
k - Fuel Injectors (8)
l - Fuel Rail

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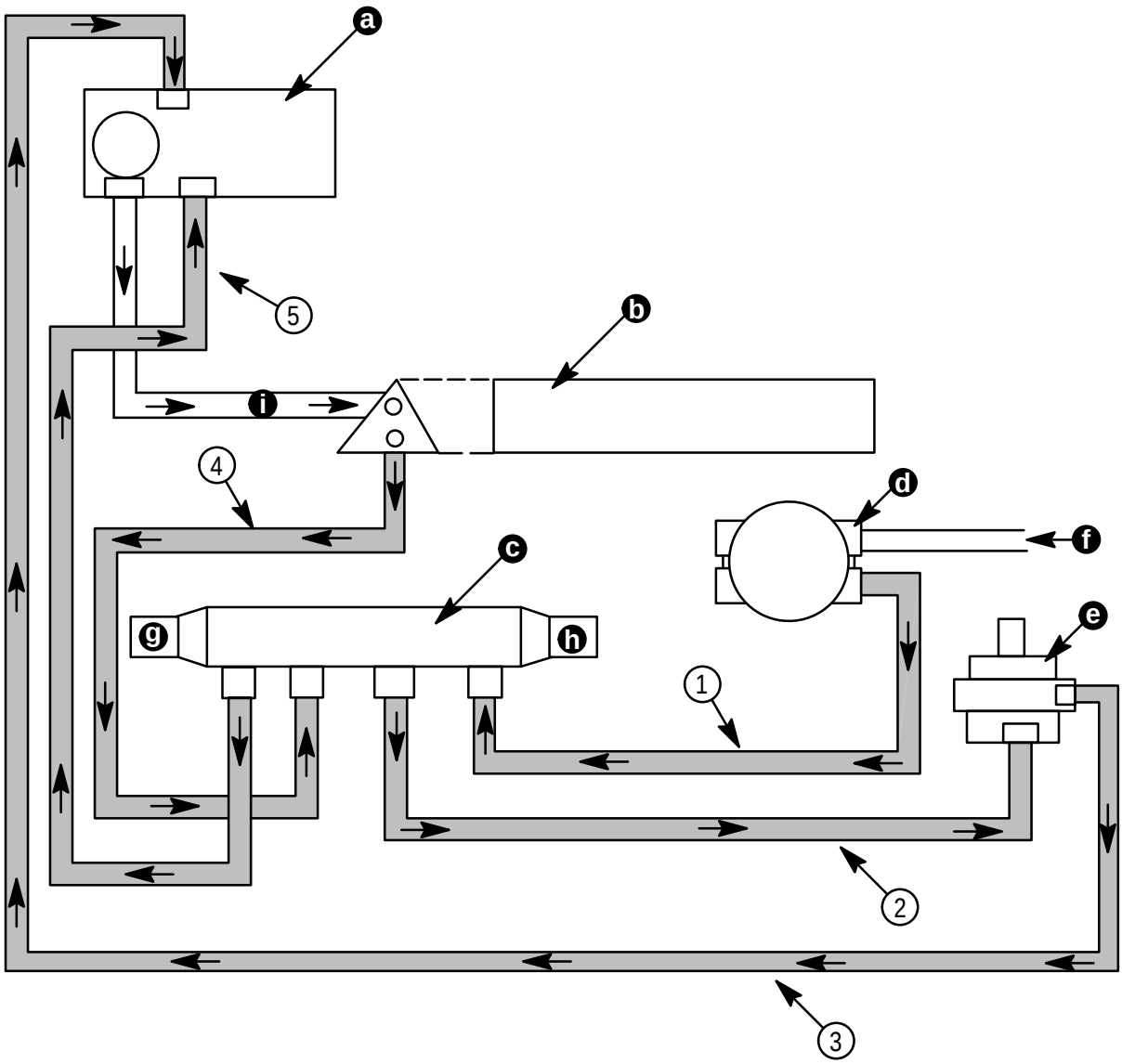
Fuel Cooler Kit For MIE Inboard (Starboard Mounted)



a - Vapor Separator Tank (VST)
b - Fuel Rail
c - Fuel Cooler
d - Water Separating Fuel Filter
e - Fuel Pump
f - Fuel Line From Fuel Tank
g - Seawater Inlet Hose Connection Point
h - Seawater Hose - Cooler to Inlet Side of Seawater Pump
i - High Pressure Fuel Line - VST to Fuel Rail (This Fuel Line Stays The Same)

1 - Fuel Line - Filter to Cooler [16-1/2 in. (420mm)]
2 - Fuel Line - Cooler to Fuel Pump Inlet [22-1/2 in. (572 mm)]
3 - Fuel Line - Pump Outlet to Vapor Separator Tank Supply Fitting [57 in. (1448 mm)]
4 - Fuel Line - Fuel Rail to Cooler [32-1/2 (825 mm)]
5 - Fuel Line - Cooler to Vapor Separator Tank Fuel Return Fitting [31 in. (787 mm)]

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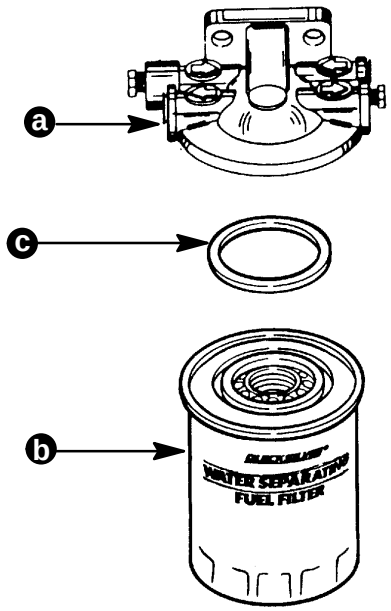
Water Separating Fuel Filter

NOTICE

Refer to “Precautions,” in this section, BEFORE proceeding.

The water separating fuel filter is standard on all engines.

The fuel filter consists of the fuel filter base and filter element.



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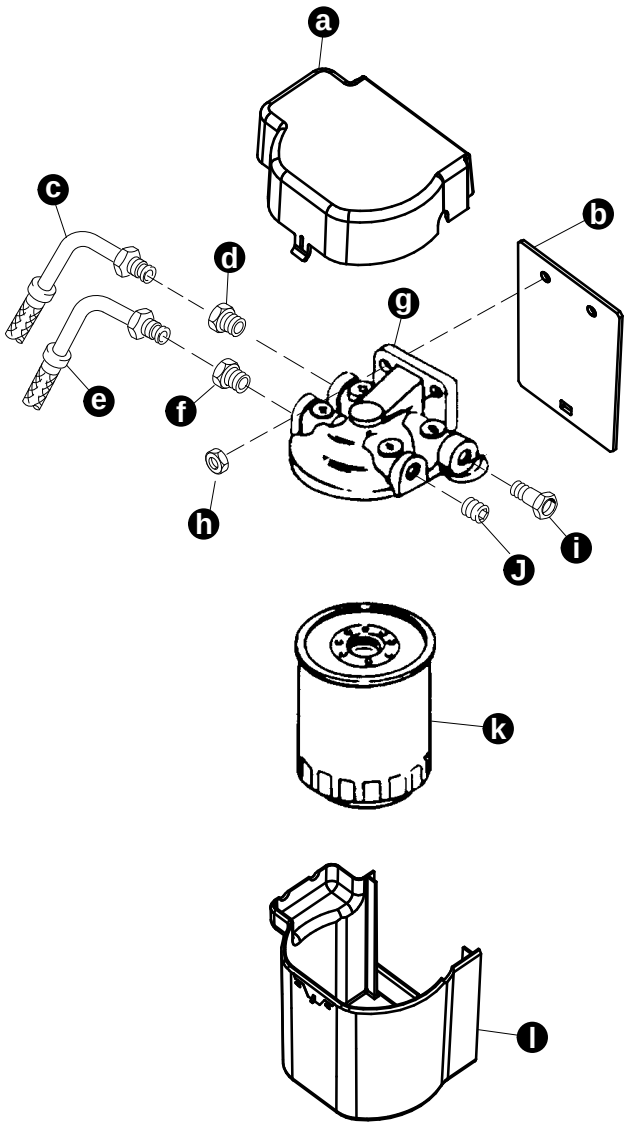
Carburetor and VST Equipped Engines

a - Fuel Filter Mounting Bracket
b - Filter Element
c - Sealing Ring



Cool Fuel System Water Separating Fuel Filter

a - Top Cover
b - Insulator Plate
c - Fuel Outlet To Throttle Body Or Fuel Rail
d - Brass Fitting
e - Fuel Return
f - Brass Fitting
g - Fuel Filter Mounting Bracket
h - Nut
i - Inlet Fuel Fitting
j - Plug
k - Water Separating Fuel Filter
l - Bottom Cover

Replacement

NOTICE

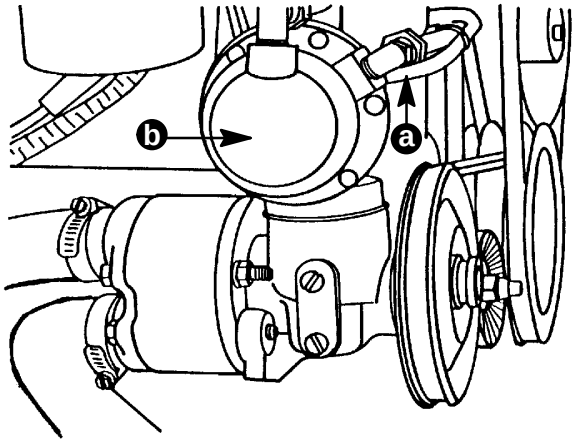
Refer to “Precautions,” in this section, BEFORE proceeding.

1. Disconnect battery cables from battery.
2. Remove fuel filter from base. A filter wrench may be needed to loosen element.
3. Lubricate sealing ring(s) of new filter with SAE engine oil.
4. Install new filter, tightening securely by hand.
5. Reconnect battery cables, make sure water is supplied to cooling system, start engine, and check for fuel leaks.

Sight Tube

Inspection

Fuel pump is equipped with sight tube. Evidence of fuel in the sight tube indicates a ruptured diaphragm and fuel pump must be replaced immediately.



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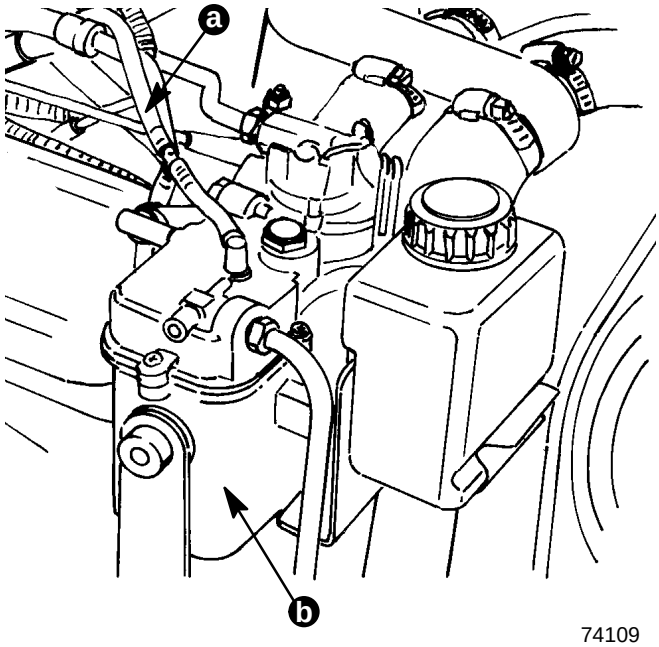
Seawater / Mechanical Fuel Pump

a - Sight Tube
b - Fuel Pump



74109

Vapor Separator Tank (VST)

a - Sight Tube
b - Vapor Separator Tank (VST)

Testing Mechanical Fuel Pump

NOTICE

Refer to "Precautions," in this section, BEFORE proceeding.

1. Disconnect battery cables from battery.
2. Remove fuel line from carburetor or outlet side of fuel pump.
3. Install Fuel Pressure Connector (91-18078) to carburetor and reinstall fuel line. Tighten connector and fuel line securely.
4. Connect fuel pressure test gauge to connector.
5. Reconnect battery cables, start engine, and run at 1800 RPM.
6. Fuel pressure should be within specifications. If not, replace fuel pump.

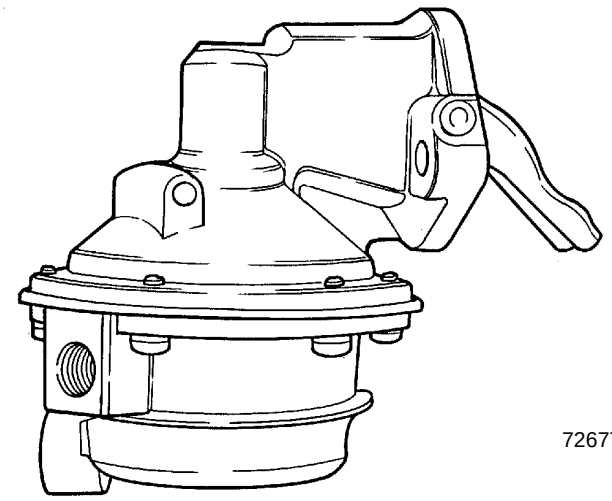
Mechanical Fuel Pump

NOTICE

Refer to "Precautions," in this section, BEFORE proceeding.

Replacement

IMPORTANT: The fuel pump cannot be repaired. If pump fails, it must be replaced.



72677

1. Disconnect battery cables from battery.

⚠ CAUTION

Plug fuel supply hose after removal to prevent fuel from leaking into boat.

2. Use a wrench to stabilize brass coupling at fuel filter inlet fitting, loosen fuel line fitting, disconnect and suitably plug fuel line to prevent fuel in tank from leaking into bilge.
3. Remove fuel filter.
4. Using wrench to stabilize brass couplings on fuel pump, loosen fuel line fittings and disconnect from fuel pump.
5. Clean gasket from seawater pump.
6. Apply Quicksilver Perfect Seal to both sides of fuel pump gasket and install on fuel pump.
7. Install fuel pump. Torque bolts to 25 lb. ft. (34 N·m).
8. Install fuel inlet and outlet fittings to fuel pump as outlined next:

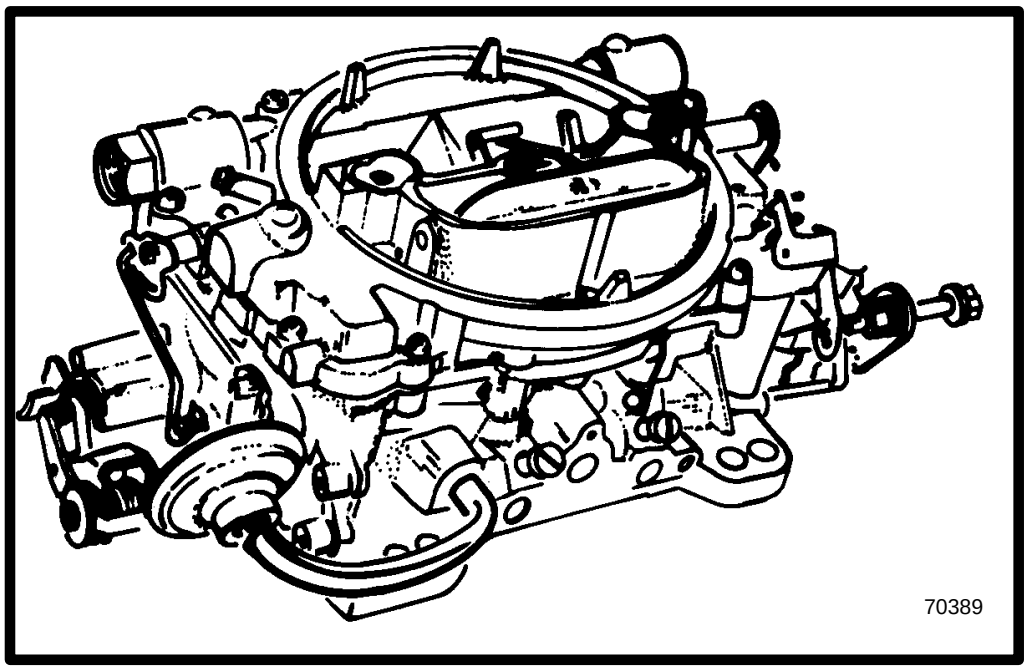
⚠ WARNING

Avoid gasoline fire or explosion. Improper installation of brass fittings or plugs into fuel pump or fuel filter base can crack casting and/or cause a fuel leak.

- **Apply #592 Loctite Pipe Sealant with Teflon to threads of brass fitting or plug. DO NOT USE TEFLON TAPE.**
- **Thread brass fitting or plug into fuel pump or fuel filter base until finger tight.**
- **Tighten fitting or plug an additional 1-3/4 to 2-1/4 turns using a wrench. DO NOT OVER-TIGHTEN.**
- **Install fuel line. To prevent over-tightening, hold brass fitting with suitable wrench and tighten fuel line connectors securely.**
- **Check for fuel leaks.**

9. Install sight tube.
10. Install fuel line and fuel filter.
11. Reconnect battery cables.
12. Make sure water is supplied to cooling system and start engine. Check for fuel leaks.

FUEL SYSTEM



5

B

WEBER 4 BARREL CARBURETOR

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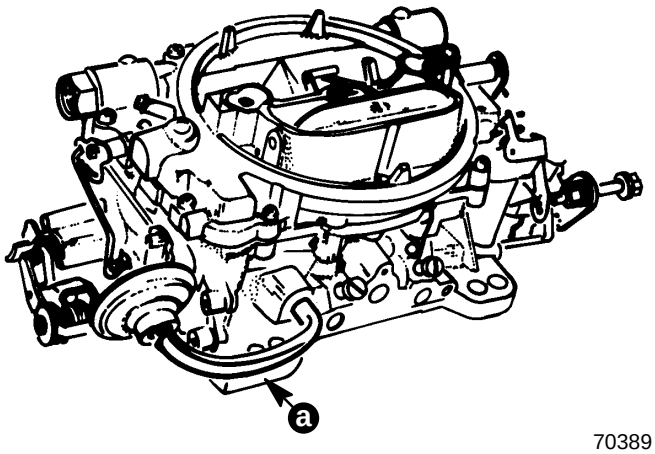
NOTICE

For information and procedures on trouble-shooting, refer to Section 1C.

Identification



70389

a - Weber Identification Number Location

Replacement Parts Warning

⚠ WARNING

Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

Torque Specifications

Fastener Location	in. lb.	lb. ft.	N·m
Carburetor To Manifold	132		15
Fuel Line To Carburetor		18	24

Tools

Description	Part Number
Universal Carburetor Gauge	91-36392
Tachometer	91-59339
Universal Carburetor Stand	Obtain Locally
Torx® Screwdriver (15,20,25)	

TORX SCREWDRIVERS

Weber carburetors will have a “star” shaped socket in the head of some screws. A TORX® screwdriver must be used on this type of screw. The sizes used are numbers 15, 20 and 25.

Specifications

MCM Carburetor

Engine Model	Carb Type	Mercury Number (Manufacturer Number)	Primary Jet Size	Secondary Jet Size	Metering Rod Number	Metering Rod Spring Color
MCM 7.4L SN OF352105 and Below	WFB	3310-818659 (9772)	.107 in.[1]	.098 in.[1]	16-6542	Pink
MCM 7.4L SN OF352106 and Above		3310-806969 (9780S)	.104 in.	.098 in.	16-757347	Green
MCM 7.4L Bravo Three SN OF070156 and Above		3310-818659 (9772)	.107 in.[1]	.098 in.[1]	16-6542	Pink
MCM 7.4L Bravo Three SN OF070155 and Below		3310-805569 (9777)	.107 in.[1]	.098 in.[1]	16-7147	Pink
MCM 7.4L		3310-806969 (9780)	.104 in.	.098 in.	16-757347	Green
MCM 454 Magnum SN OF304599 and below		3310-816917 (9773)	.107 in.	.107 in.	16-6542	Pink
MCM 454 Magnum SN OF305000 and Above		3310-806755 (9779, 9779S)	.106 in.	.092 in.	16-757347	Green
MCM 454 Magnum						
MCM 502 Magnum		3310-805341 (9776) 3310-806791 (9776S)	.110 in.	.101 in.	16-7147	Pink

[1] 7.4L Engines with the following serial numbers may have staggered jets in the main and/or secondary jets. They should be changed to jets listed above for that respective carburetor.

MCM (Stern Drive) serial numbers OF022828 and below
MIE (Inboard) serial number OD857999 and below

Specification (continued)

MIE Carburetor

Engine Model	Carb Type	Mercury Number (Manufacturer Number)	Primary Jet Size	Secondary Jet Size	Metering Rod Number	Metering Rod Spring Color
MIE 7.4L Bluewater	WFB	3310-818659 (9772)	.107 in.	.098 in.	16-6542	Pink
		3310-806969 (9780, 9780S)	.104 in.	.098 in.	16-757347	Green
MIE 8.2L Bluewater		3310-817693 (9774) See Note 1	Port Side .104 in. Starboard Side .107 in.	.098 in.	16-6542	Pink
MIE 8.2L Bluewater		3310-805341 (9776S)	.110 in.	.101 in.	16-7147	Pink
		3310-805341 (9776SA)				
		3310-806971 (9776SB)				

Note1: This model carburetor had staggered primary jets.

Jet Changes for Altitude (Change Only Secondary Jets)

Model	Part Number	5000 ft. (1525 m) and below	5000-9000 ft. (1525-2745 m)	9000 ft. (2745 m) and above
7.4L Bravo Automatic Choke	3310-818659A (9772)	.098 in. Port .077 In. Starboard	.092 in. Port .074 in. Starboard	.089 in. Port .071 in. Starboard
	3310-818659A (9772SA)	.098 in.	.092 in.	.089 in.
7.4L Bravo Electric Choke	3310-806969 (9780S)	Stock 3 Step Metering Rod	Elevation Kit #1 (See Note)	
7.4L Bravo Three Electric Choke Serial # OF838819 to OF800699	3310-805569A (9777)	.098 in.	.092 in.	.089 in.
7.4L Bravo Three Electric Choke	3310-806755A (9779S)	Stock 3 Step Metering Rod	Elevation Kit #1 (See Note)	
454 Magnum Automatic Choke	3310-816917A (9773)	.107 in.	.101 in.	.098 in.
454 Magnum Electric Choke	3310-806755A (9779S)	Stock 3 Step Metering Rods	Elevation Kit #2 (See Note)	
502 Magnum Automatic Choke	3310-805341 (9776)	.101 in.	.095 in.	.092 in.
	3310-806791A (9776SA)			
502 Magnum Electric Choke	3310-806971A (9776SB)			
7.4L Inboard Automatic Choke	3310-818659A (9772)	.098 in. Port .077 In. Starboard	.092 in. Port .074 in. Starboard	.089 in. Port .071 in. Starboard
	3310-818659A (9772SA)	.098 in.	.092 in.	.089 in.
7.4L Inboard Electric Choke	3310-806969 (9780S)	Stock 3 Step Metering Rod	Elevation Kit #1 (See Note)	
8.2L Inboard Automatic Choke	3310-805341 (9776)	.101 in.	.095 in.	.092 in.
	3310-806791A (9776SA)			
8.2L Inboard Electric Choke	3310-806971A (9776SB)			

NOTE: *Elevation Kit Number 1 (Part Number 809615)*
Elevation Kit Number 2, 454 Magnum Only (Part Number 809620)

UNIT OF MEASUREMENT In. (mm) ALL MEASUREMENTS ARE ± 1/64 In. (0.4 mm).

MCM Carburetor Adjustment Specifications

Engine Model	7.4L / 7.4L Bravo Three	454 Bravo	502 Bravo
Carburetor Manufacturer Number	9772, 9777 9779S, 9780S	9773, 9779S	9776, 9776SA, 9776SB
Float Level	1-9/32 in. (33 mm)		
Float Drop	2 in. (51 mm)		
Pump Rod Hole Location	Third Hole From End		
Accelerator Pump	7/16 in. (11 mm) [1]		
Choke Pull-Off	15/64 in. (6 mm)		
Choke Coil Rod	Top Of Rod Even With Bottom Of Lever Hole [2]		
Preliminary Mixture Idle Screw Setting	1-1/4 Turns		

MIE Carburetor Adjustment Specifications

Engine Model	7.4L	8.2L
Carburetor Manufacturer Number	9772, 9780S	9774, 9776, 9776S, 9776SB
Float Level	1-9/32 in. (33 mm)	
Float Drop	2 in. (51 mm)	
Pump Rod Hole Location	Third Hole From End	
Accelerator Pump	7/16 in. (11 mm) [1]	
Choke Pull-Off	15/64 in. (6 mm)	
Choke Coil Rod	Top Of Rod Even With Bottom Of Lever Hole [2]	
Preliminary Mixture Idle Screw Setting	1-1/4 Turns	

[1] Measured from top of carburetor to bottom of S-link

[2] Remove choke rod from lever hole. Choke held closed and choke rod pushed down with top edge of rod even with bottom edge of hole.

Description

Weber WFB carburetor is unique in design, as the main body and flange are cast as a one piece unit. This, along with the bowl cover, make up the two piece construction which is made of light, durable aluminum to dissipate heat.

There are two separate float circuits. Each float circuit supplies fuel to a primary low speed circuit and a primary and secondary high speed circuit. The bowls are vented to the inside of the air horn. A connecting vent passage effects a balance of the air pressure between the two bowls.

The float needle valves are installed at an angle to provide the best possible seating action on the needles. This provides better needle response to float movement, also.

The high speed circuits use staged step-up rods in the main metering jets to control the amount of fuel admitted to the nozzles. The position of the step-up rod is controlled by manifold vacuum applied to the vacuum piston.

A primary air bleed located in the venturi cluster prevents a rich condition or bog as the high speed circuit is reactivated after deceleration.

Small “L” shaped metal tabs, called “distribution tab(s),” are attached to some venturi clusters and protrude into the air stream at the proper location to aid distribution of fuel on selected applications.

Precautions

⚠WARNING

Always disconnect battery cables from battery BEFORE working on fuel system to prevent fire or explosion.

⚠WARNING

Be careful when cleaning flame arrestor and crankcase ventilation hose: gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark or open flame in area when cleaning flame arrestor and crankcase ventilation hose.

⚠WARNING

Be careful when changing fuel system components: gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark or open flame in area while changing fuel filter. Wipe up any spilled fuel immediately.

Fuel Supply Connections

⚠WARNING

Avoid gasoline fire or explosion. Improper installation of brass fittings or plugs into fuel pump or fuel filter base can crack casting and/or cause a fuel leak.

- **Apply #592 Loctite Pipe Sealant with Teflon to threads of brass fitting or plug. DO NOT USE TEFLON TAPE.**
- **Thread brass fitting or plug into fuel pump or fuel filter base until finger tight.**
- **Tighten fitting or plug an additional 1-3/4 to 2-1/4 turns using a wrench. DO NOT OVER-TIGHTEN.**
- **Install fuel line. To prevent over-tightening, hold brass fitting with suitable wrench and tighten fuel line connectors securely.**
- **Check for fuel leaks.**

⚠WARNING

Make sure no fuel leaks exist, before closing engine hatch.

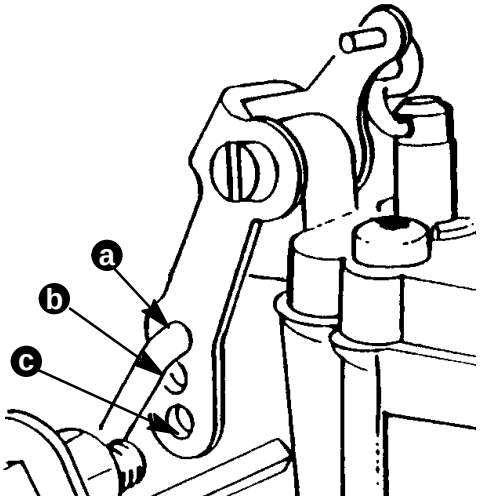
⚠CAUTION

DO NOT operate engine without cooling water being supplied to water pickup holes in gear housing or water pickup inlet, or water pump impeller will be damaged and subsequent overheating damage to engine may result.

Important Service Information

Weber Carburetor Adjustable Accelerator Pump

The accelerator pump lever on Weber Carburetors has three holes in it. The closest hole to the lever's pivot point is the richest, the second hole is leaner and the hole furthest away is the leanest. All production carbs have the pump rod installed in the closest (richest) hole. If you are having a "rich" bog on acceleration, move the rod to the second or third hole. Weber put the three holes in the lever so the amount of fuel delivered by the accelerator pump could be changed.



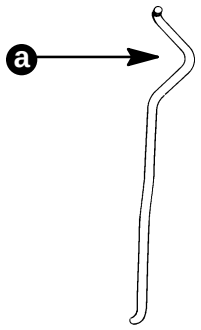
70472

a - Rich
b - Lean
c - Leaner

Hard Starting

If a hard starting condition exists, after engine has not been operated for a period of time, proceed with the following:

1. Before starting engine, remove flame arrestor then operate throttle to see if choke closes.
2. If choke is stuck open, check choke stove link rod and choke linkage on both sides of carburetor for cause of sticking. Possible paint or interference to rod or linkage.
3. If choke plate does not close tight step 2 or 3, then choke link rod will have to be bent to make it shorter so it will close choke plate completely.



73716

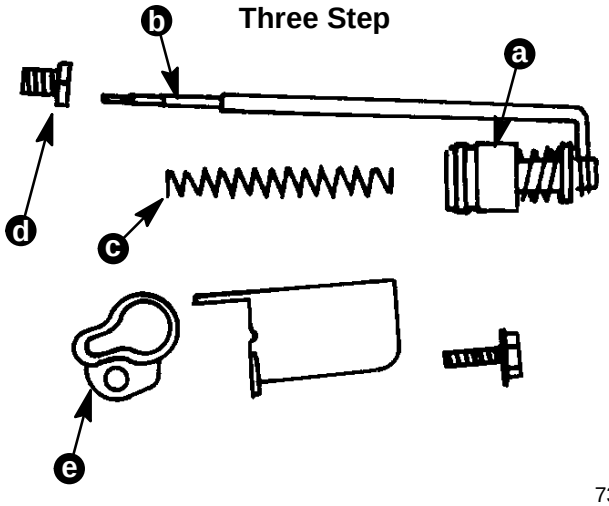
a - Bend Here To Shorten

4. After installing, ensure that the rod does not rub against stove cover or carburetor throughout its travel.

Carburetor Metering Rod And Jet Indentification

METERING ASSEMBLY

The metering rod assemblies are different in the following ways:



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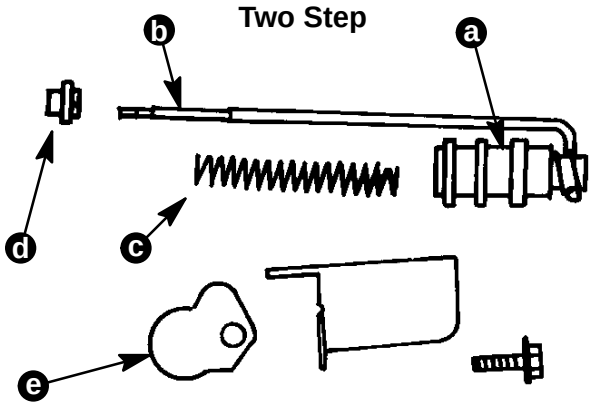

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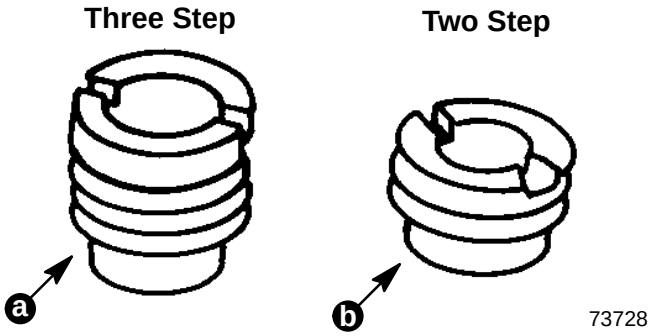
a - Piston
b - Metering Rod
c - Spring
d - Jet
e - Piston Cover

METERING JETS

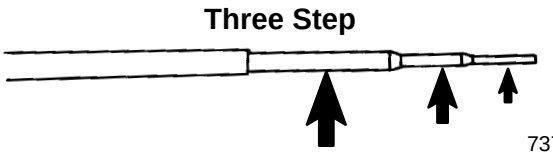
The metering jets in this carburetor are taller than the jets in a standard carburetor.



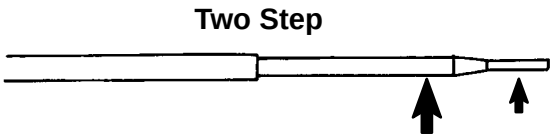
73728

a - Three Step Metering Rod
b - Two Step Metering Rod

METERING ROD HAS “THREE STEPS” -VS- TWO

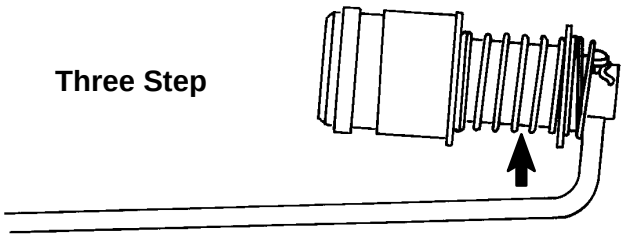


73726

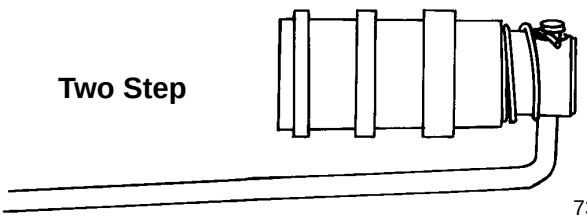


73724

PISTON SHAPE IS DIFFERENT AND HAS A SECOND SPRING

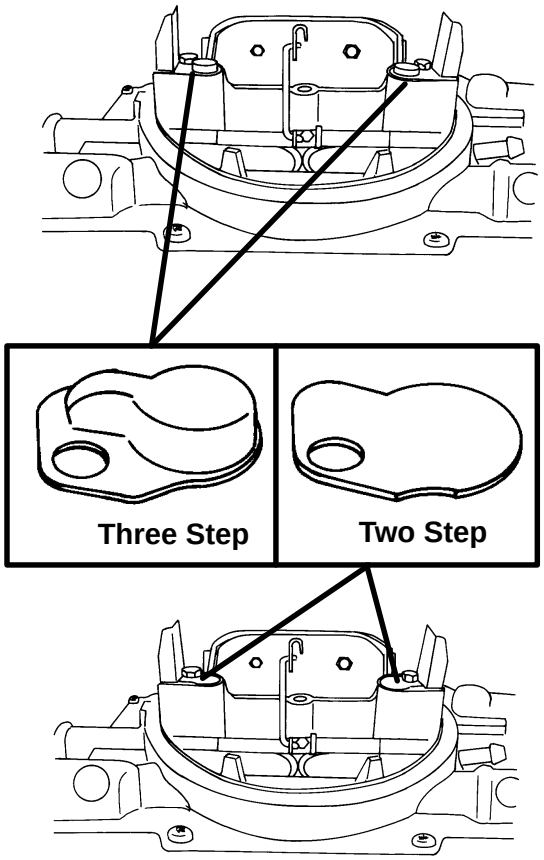


73730



73727

PISTON ASSEMBLY COVER IS HIGHER

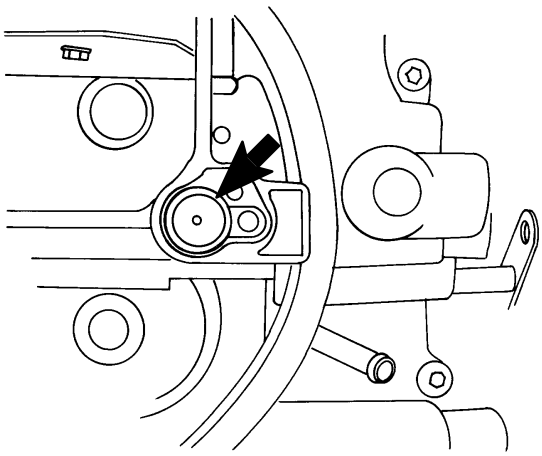


73735

73725

73736

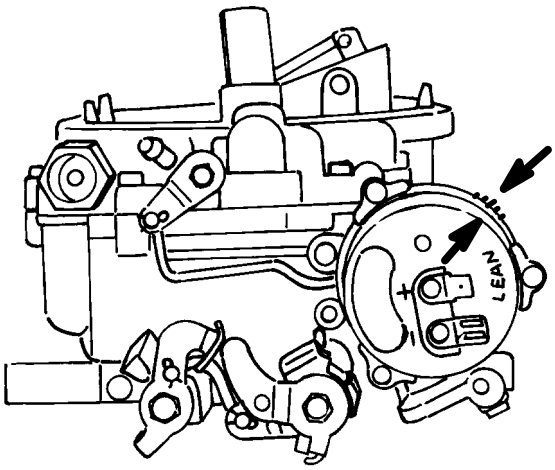
PISTON BORE HAS A STEP ON THREE STEP MODEL



73737

ELECTRIC CHOKE

The electric choke should be set with marks aligned.



74104

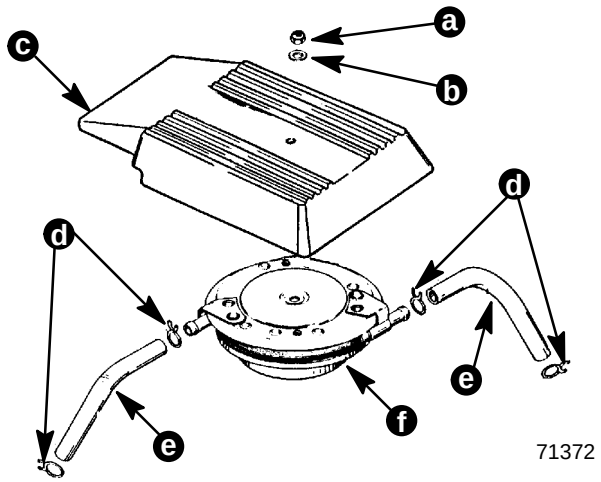
Maintenance

Flame Arrestor

NOTICE
Refer to "Precautions," in this section, BEFORE proceeding.

5. Remove (in the following order):
   a. Nut
   b. Sealing washer
   c. Carburetor cover
   d. Crankcase ventilation hoses from flame arrestor and rocker arm covers
   e. Flame arrestor
6. Clean and inspect:
   a. Clean flame arrestor in solvent and blow dry with compressed air.
   b. Clean crankcase ventilation hoses.
   c. Inspect crankcase ventilation hoses for cracks or deterioration, and replace if necessary.

7. Install (in the following order):
   a. Flame arrestor
   b. Crankcase ventilation hoses to flame arrestor and rocker arm covers
   c. Carburetor cover
   d. Sealing washer
   e. Nut (tighten securely)



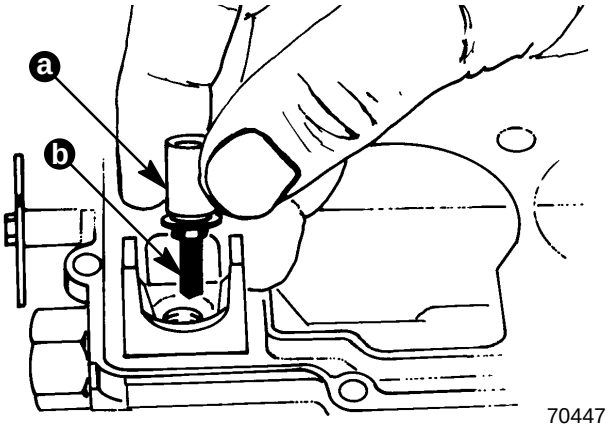
Flame Arrestor with Carburetor Cover (Typical)

a - Nut
b - Sealing Washer
c - Carburetor Cover
d - Sta-Strap
e - Crankcase Cover
f - Crankcase Ventilation Hose
g - Flame Arrestor

Fuel Filter

NOTICE
Refer to "Precautions," in this section, BEFORE proceeding.

Carburetor inlet fuel filter is installed in bottom side of fuel inlet seat (in the carburetor top). Refer to "Disassembly" and "Reassembly" to service.



a - Fuel Inlet Seat (with Gasket)
b - Fuel Inlet Filter

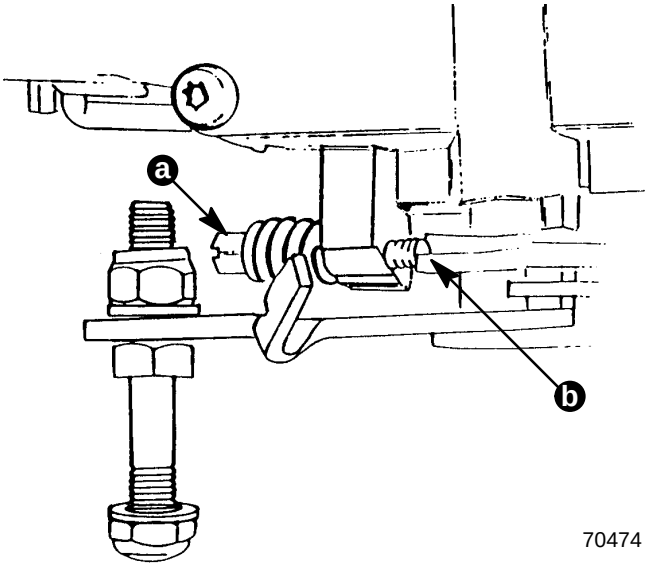
Adjustments

NOTICE
Refer to “Precautions,” in this section, BEFORE proceeding.

Accelerator Pump

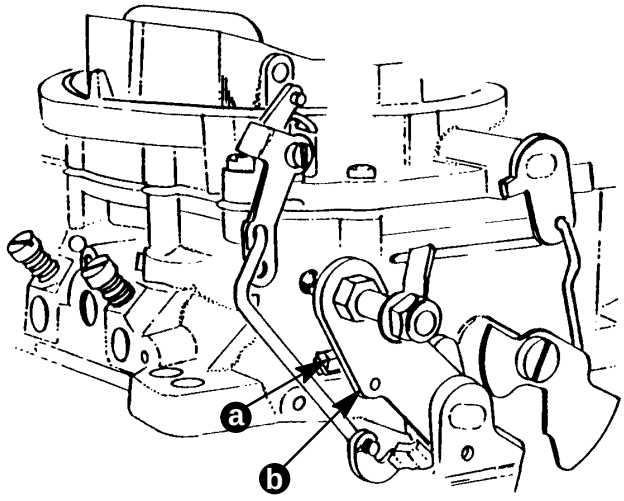
IMPORTANT: Refer to “Important Service Information” in this section, regarding the three accelerator pump linkage holes and placement of linkage rod.

1. Back out idle speed screw until it no longer contacts throttle lever.



70474

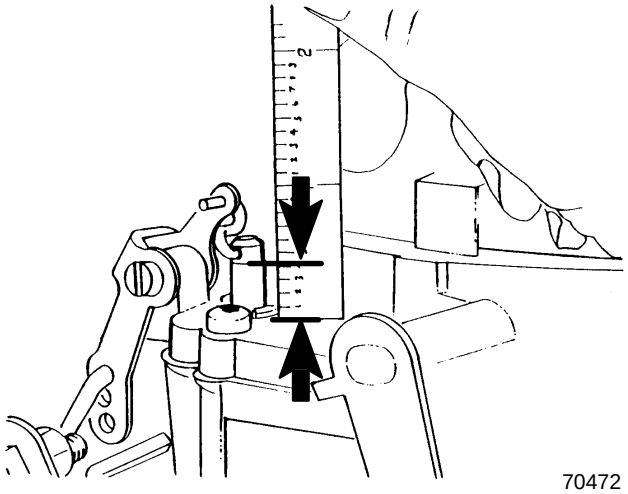
a - Idle Speed Screw
b - Throttle Lever Contact Point



70473

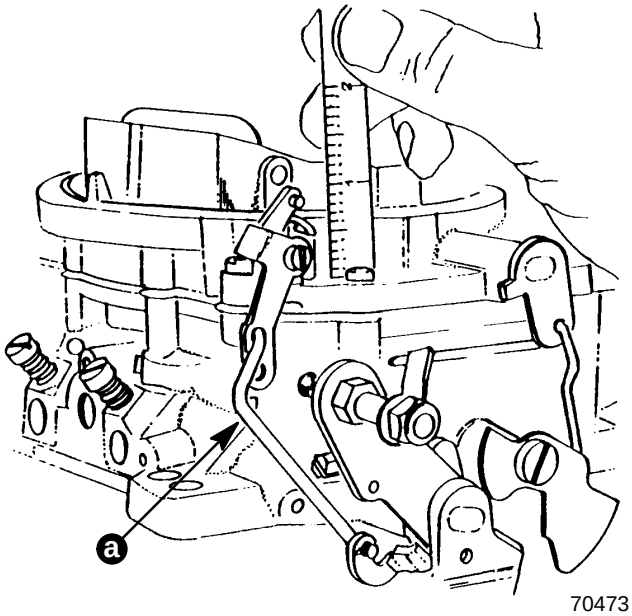
a - Idle Speed Screw
b - Throttle Lever

2. Close throttle valves completely.
3. Accelerator pump is set at 7/16 in. (11 mm), which is measured from the carburetor top to the bottom of the S-link as shown.



70472

4. Adjustment of accelerator pump is done by bending the linkage as necessary to achieve the proper dimension as stated above.

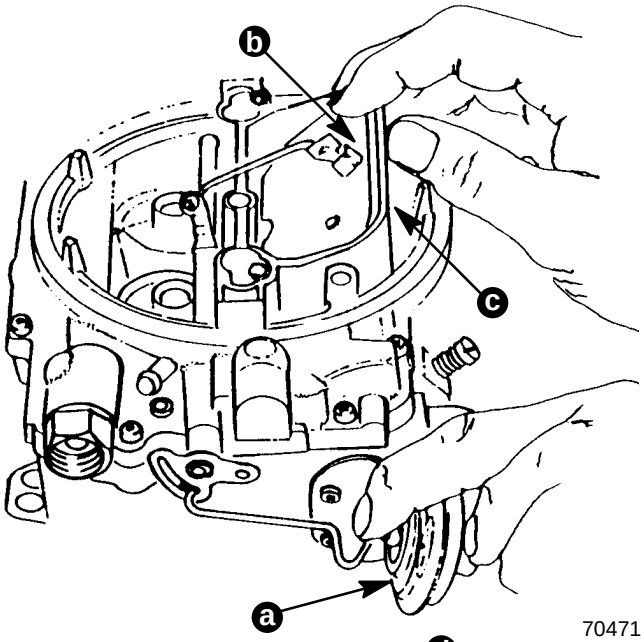


70473

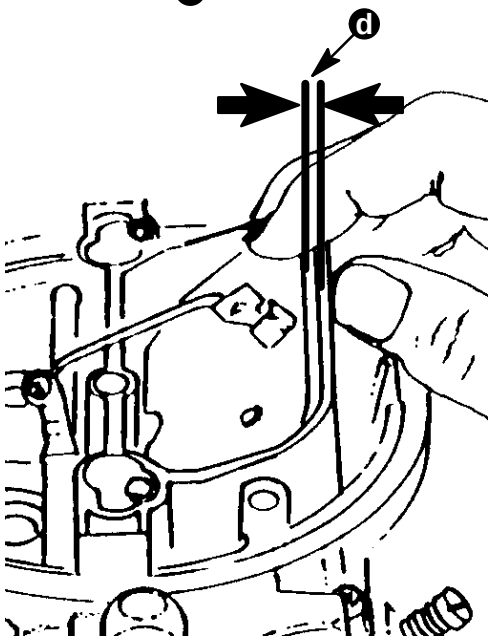
a - Bend Here

Choke Pull-Off

1. Choke pull-off is checked by holding in on vacuum diaphragm and attempting to close choke plate. The gap between the plate and housing is to be set at15/64 in. (6 mm).



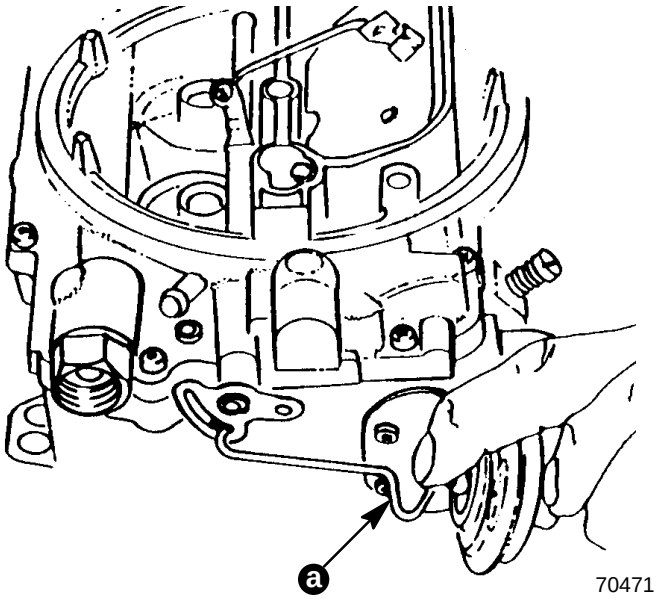
70471



70471

a - Vacuum Diaphragm
b - Choke Plate
c - Housing
d - Gap Measurement

2. Bend choke pull-off linkage to achieve setting given in Step 1.

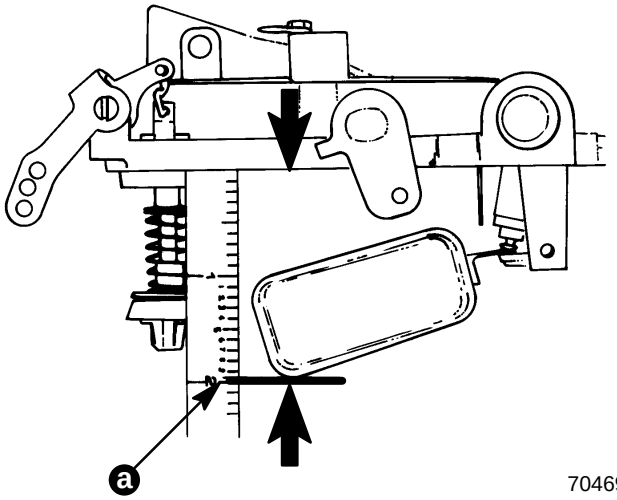


70471

a - linkage (Bend)

Float Drop

1. Measure float drop from bottom side of carburetor top to toe of float (lowest part), as shown. It must be set at 2 in. (51 mm).

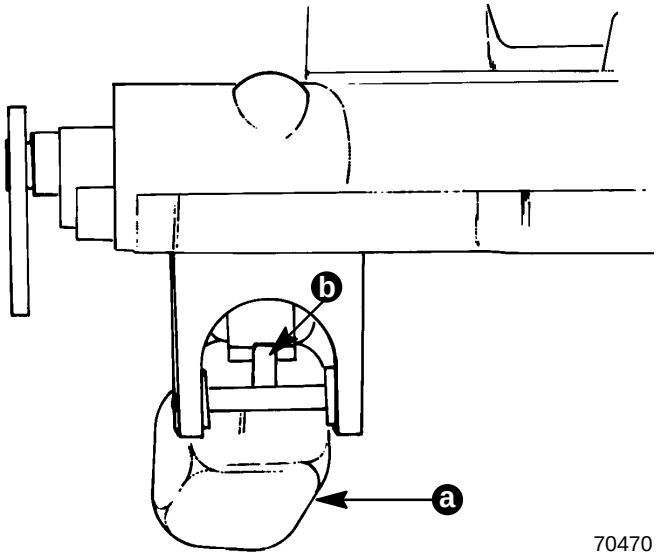


70469

a - Drop Measurement

2. If float drop is not correct, hold hinge pin firmly and bend tab shown, as needed.

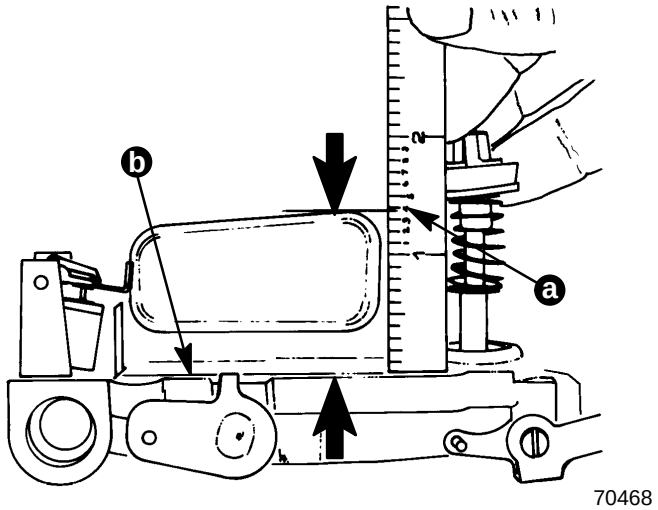
IMPORTANT: Do not put pressure on fuel needle valve and seat while bending tab, or damage may result.



a - Float
b - Tab (Bend)

Float Level

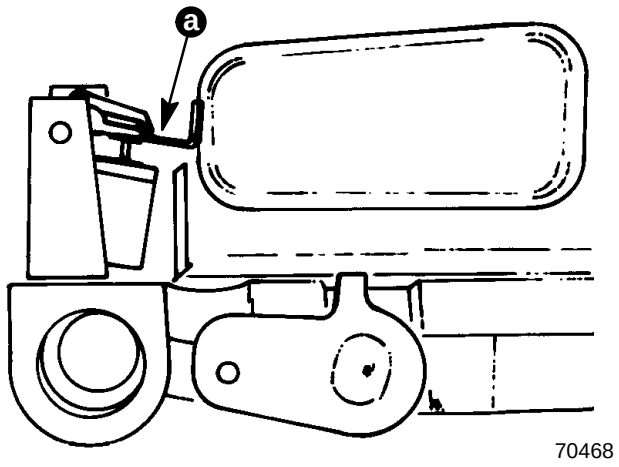
1. Measure float level from bottom side of carburetor top (with gasket in place) to toe of float as shown. It must be set at 1-9/32 in. (33 mm).



a - Float Level Measurement
b - Gasket

2. If float level requires adjustment, hold hinge pin firmly and bend float arm shown, as needed.

IMPORTANT: Do not put pressure on fuel needle valve and seat while bending tab, or damage may result.



a - Float Level Tab (Bend)

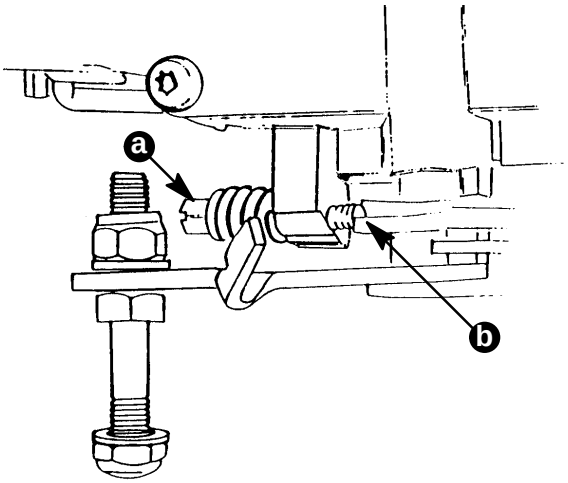
Idle Speed and Mixture Adjustments

Thunderbolt IV Equipped Engines

PRELIMINARY IDLE SPEED AND MIXTURE

Initial start settings are given following. Make final adjustment with engine running (refer to “Final Idle Speed and Mixture”).

1. Turn idle speed screw until it contacts throttle lever.

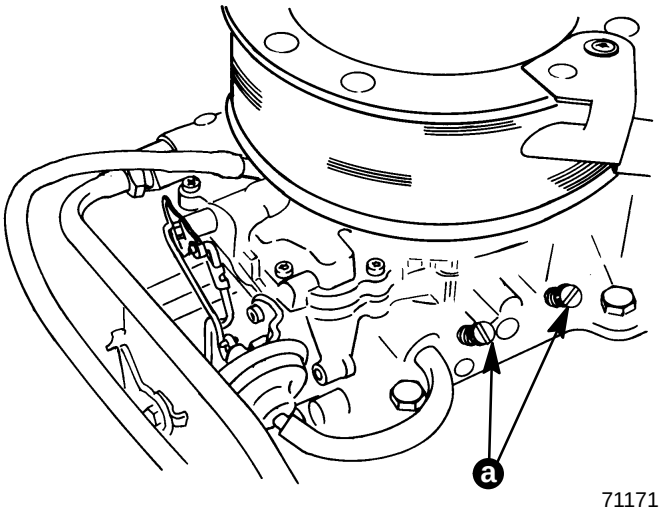


70474

a - Idle Speed Screw
b - Throttle Lever Contact Point

2. Turn idle mixture screws (needles) in (clockwise) until LIGHTLY seated, then back out 1-1/4 turns.

IMPORTANT: Do not turn idle mixture screws tightly against seat, as damage to seat and/or needle may result.



71171

a - Idle Mixture Screws (Needles)

FINAL IDLE SPEED AND MIXTURE

IMPORTANT: Boat MUST BE in the water and engine at normal operating temperature to accurately check and adjust idle speed and mixture.

Carburetor should be set so that engine idles as smoothly as possible, with boat in the water, engine normal operating temperature and drive unit in forward gear. To adjust idle speed and mixture, proceed as follows:

IMPORTANT: DO NOT attempt to compensate for other engine problems (incorrect ignition timing, faulty ignition components, low compression, vacuum leaks, etc.) with carburetor adjustments. This will only cover the problem, which must be corrected if engine is to achieve maximum fuel economy and performance.

1. Connect a shop tachometer to engine.

IMPORTANT: DO NOT turn idle mixture screws (needles) tightly into seat, as damage to needle and/or seat may result.

2. If a new or rebuilt carburetor has been installed, turn each idle mixture screw until it LIGHTLY contacts seat (if not already accomplished), then back out 1-1/4 turns. This will provide a sufficient setting to allow starting the engine.
3. Start engine and run at 1500 RPM until engine reaches normal operating temperature.

⚠ WARNING

DO NOT leave helm unattended while performing idle speed and mixture adjustments, following. BE CAREFUL NOT TO ACCIDENTALLY ACCELERATE ENGINE WHILE PERFORMING ADJUSTMENTS.

4. With boat in open water, place remote control in forward gear, idle position.
5. Disconnect throttle cable barrel from anchor stud. BE SURE NOT TO LOSE SPACER ON ANCHOR STUD.
6. Adjust idle speed adjustment screw to obtain specified idle RPM. (Refer to Section 1B - “Tune-Up Specifications” charts.)

NOTE: *Idle speed must be at specified RPM or less. Or engine will be operating on the off idle circuit. Mixture screw adjustments will be ineffective if this condition exists.*

7. With engine running at or just below specified idle RPM, adjust idle mixture screws as follows:
   a. Turn idle mixture needle in (clockwise) until the engine speed begins to decrease due to LEAN mixture.
   b. Turn same idle mixture screw outward (counterclockwise) until the engine speed begins to decrease due to a RICH mixture.
   c. Turn screw in to a point between these two extremes to obtain maximum engine smoothness and RPM.
   d. Repeat procedure with other mixture screw.
   e. Readjust idle speed adjusting screw, if necessary, to obtain specified idle RPM.
8. Place remote control in neutral. Turn ignition OFF.
9. Accelerator pump linkage should be rechecked at this time. Refer to Steps 3 and 4, of Adjustments - “Accelerator Pump”, as previously outlined and verify pump is set at 7/16 in. (11mm) as specified.
10. Refer to SECTION 2. Install and adjust throttle cable following instructions appropriate to your power package.

Thunderbolt V Equipped Engines

ADJUSTING IDLE MIXTURE

The procedure for adjusting carburetor idle mixture can be found in the appropriate engine service manual. This procedure also requires that the ignition module be locked in the “Base Timing Mode”.

IMPORTANT: In order to properly set idle mixture, the ignition module MUST BE locked in the “Base Timing Mode”. This is necessary because of the “Idle Speed Control” feature that exists in the ignition module. See information on the previous pages about this feature.

1. Using a jumper wire, connect the ignition system timing lead “13” (PUR/WHT wire) to a good engine ground (–). This locks the ignition module into the “Base Timing Mode”.
2. Adjust idle mixture following the procedure in the appropriate engine service manual.
3. Remove the jumper wire from the timing terminal.

ADJUSTING ENGINE IDLE SPEED

This procedure should be done with boat in the water, drive unit in neutral and engine at normal operating temperature. Refer to the Operation and Maintenance Manual for the correct idle speed.

1. Disconnect the throttle cable from carburetor.

IMPORTANT: In order to properly set idle speed, the ignition module MUST BE locked in the “Base Timing Mode”. This is necessary because of the “Idle Speed Control” feature that exists in the ignition module. See information on the previous pages about this feature.

2. Connect a shop tachometer to engine.
3. Using a jumper wire, connect the ignition system timing lead “13” (PUR/WHT wire) to a good engine ground (–). This locks the ignition module into the “Base Timing Mode”.
4. Start engine and allow it to reach normal operating temperature. Place the remote control lever in forward gear, idle position.
5. Adjust idle speed to recommended RPM.
6. Stop engine. Readjust cable barrel and reinstall the throttle.

IMPORTANT: Be sure to disconnect the jumper wire from the ignition system test terminal before attempting to resume normal operations. If the jumper wire is left in place, the ignition module will operate in the “Base Timing Mode”. This means that the additional timing advance features would not be functioning.

7. Remove the jumper wire from the timing terminal.

Repair

NOTICE
Refer to “Precautions,” in this section, BEFORE proceeding.

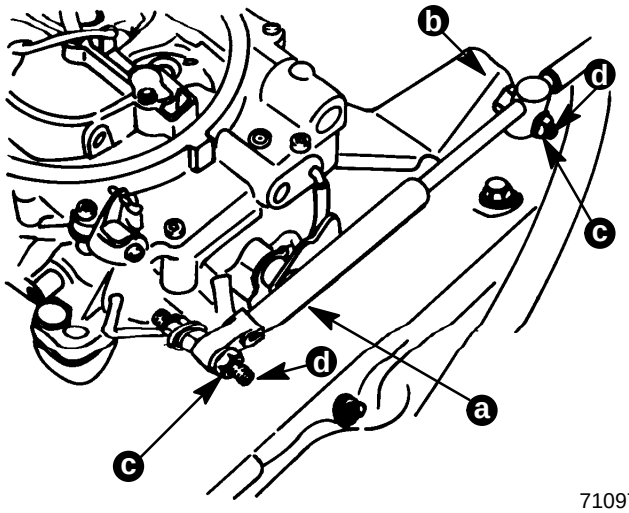
Removal

IMPORTANT: Carburetor malfunctions are, in many cases, caused by the presence of dirt, water or other foreign matter in carburetor. To aid in diagnosis, carefully remove carburetor from engine without draining fuel from bowl. Contents of fuel bowl may, then, be inspected for contamination as carburetor is disassembled.

1. Turn off fuel supply at fuel tank.
2. Remove carburetor cover. Remove crankcase ventilation hoses from flame arrestor, then remove flame arrestor.

IMPORTANT: Place a clean cloth in bores of carburetor to prevent dirt and foreign material from falling into bores.

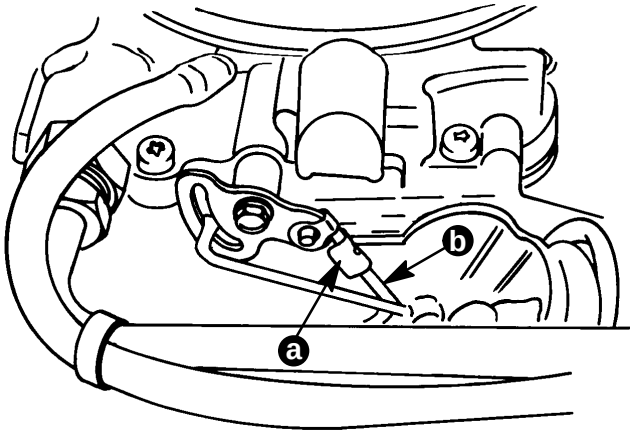
3. Disconnect throttle cable attaching hardware from throttle bracket and throttle lever anchor studs. Remove throttle cable.



71097

a - Throttle Cable
b - Bracket
c - Attaching Hardware
d - Anchor Studs

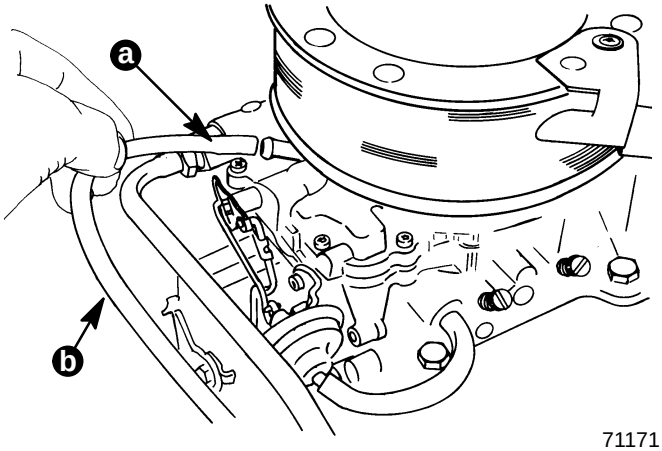
4. Disconnect retaining clip and choke linkage rod.



71096

a - Retaining Clip
b - Linkage Rod

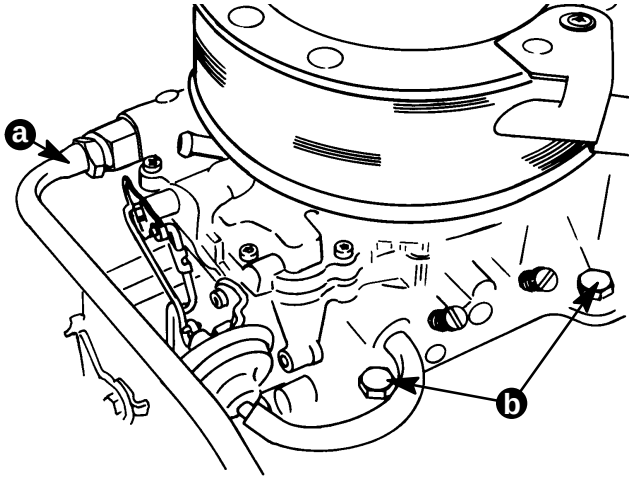
5. Disconnect fuel pump sight tube and fuel line.



71171

a - Fuel Pump Sight Tube
b - Fuel Line

6. Remove fuel line and carburetor attaching hardware. Remove carburetor and throttle bracket. Discard old gasket from carburetor.



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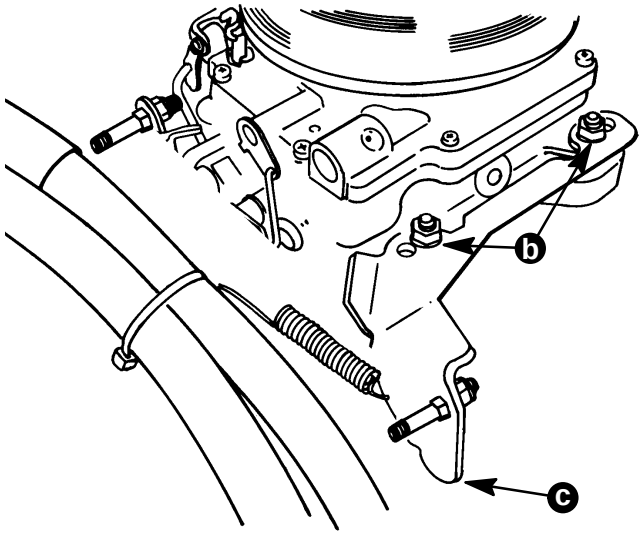


71172

a - Fuel Line
b - Attaching Hardware
c - Throttle Bracket

7. Remove adaptor/wedge plate (if so equipped) from manifold and discard old gasket.
8. Place a clean cloth over intake manifold openings.

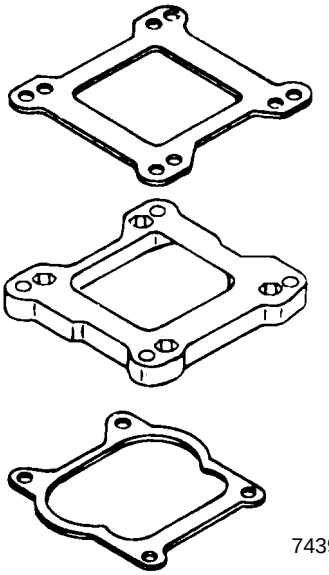
IMPORTANT: Covering intake manifold prevents entry of dirt or foreign material through openings.

Installation

1. Place appropriate new gasket on intake manifold.
2. If so equipped, install adaptor or wedge plate, depending on model. Place appropriate new gasket on top.

IMPORTANT: Carburetor is calibrated for use with an adaptor or 15° wedge plate if the model was originally so equipped. Be certain to install adaptor or 15° wedge plate if it was present upon disassembly.

MCM 7.4L BRAVO / MIE 7.4L HURTH DOWN ANGLE, VELVET DRIVE (BORG-WARNER) 5000 AND VELVET DRIVE V-DRIVE TRANSMISSIONS



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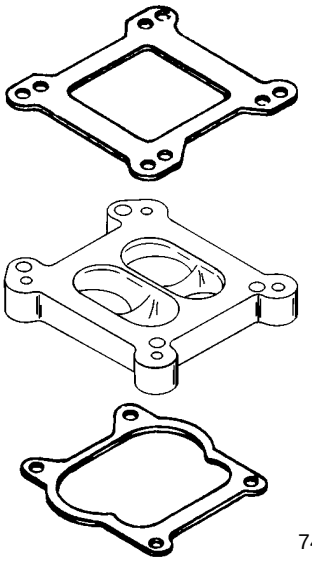

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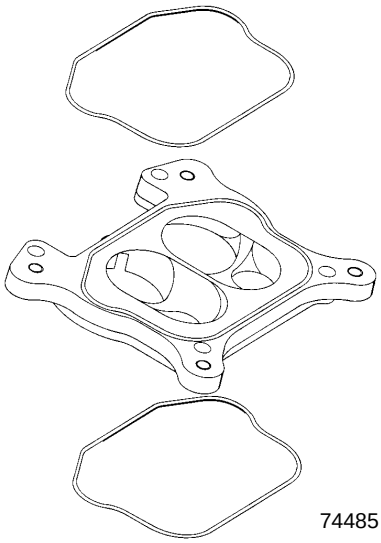
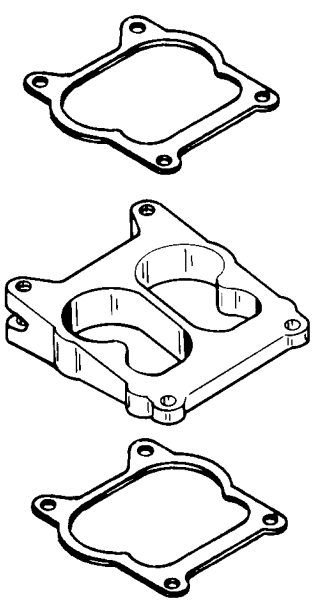
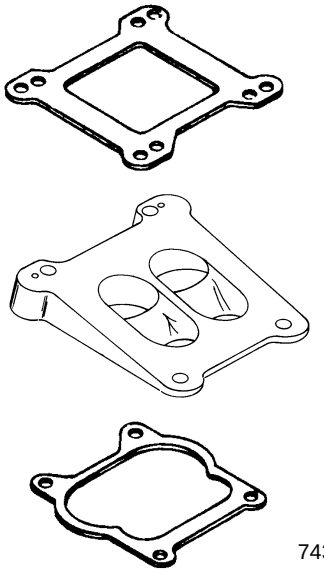


74485

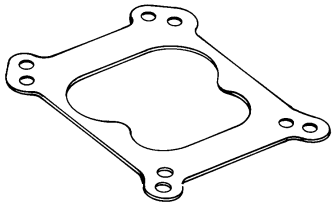
MIE 7.4L VELVET DRIVE (BORG-WARNER) IN-LINE TRANSMISSION [15 DEGREE WEDGE]





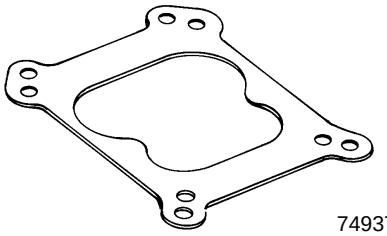
74395

MCM 7.4L PT BRAVO THREE

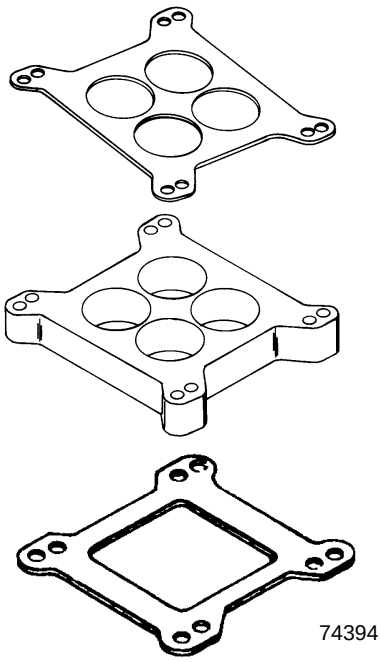


74393

MCM 454 MAGNUM

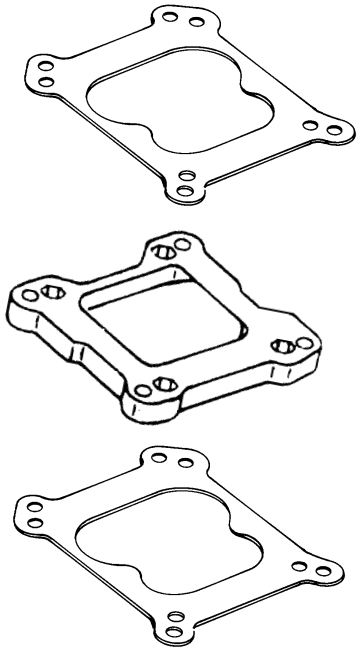


74937



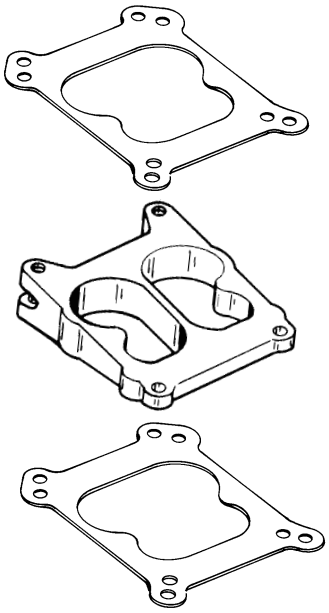
74394

MCM 502 MAGNUM



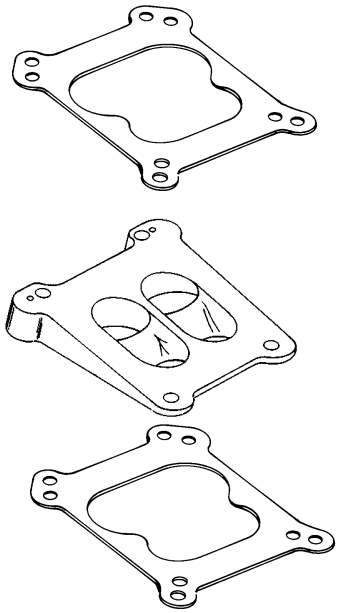
74394

MIE 8.2L VELVET DRIVE (BORG-WARNER) V-DRIVE AND HURTH DOWN ANGLE TRANSMISSIONS



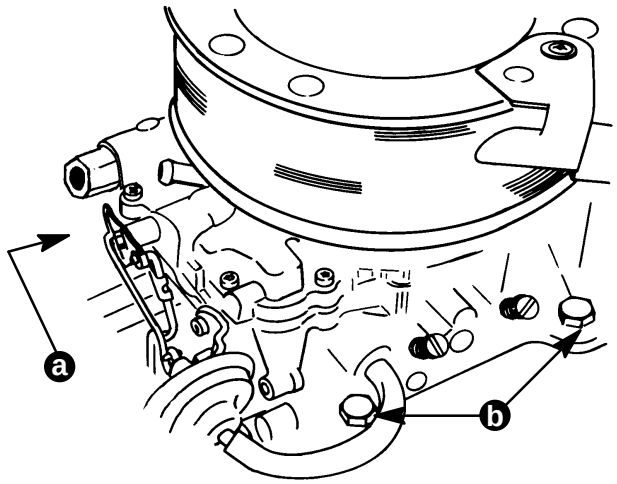
74395

MIE 8.2L VELVET DRIVE (BORG-WARNER) IN-LINE TRANSMISSION



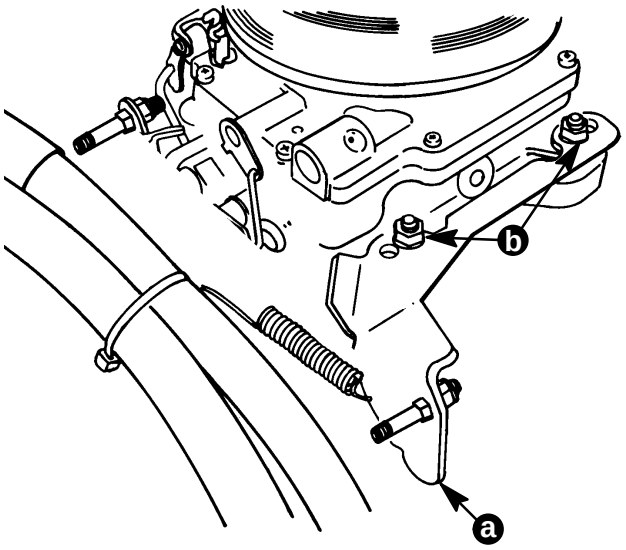
74396

3. Install carburetor and throttle bracket with attaching hardware. Torque fasteners to 132 lb. in. (15 N·m).



71173

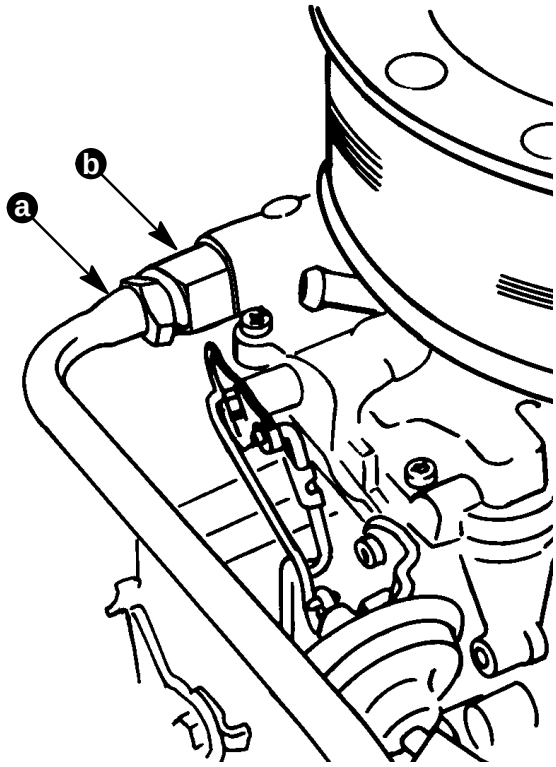
a - Throttle Bracket (Not Visible In This View)
b - Attaching Hardware



71172

a - Throttle Bracket
b - Attaching Hardware

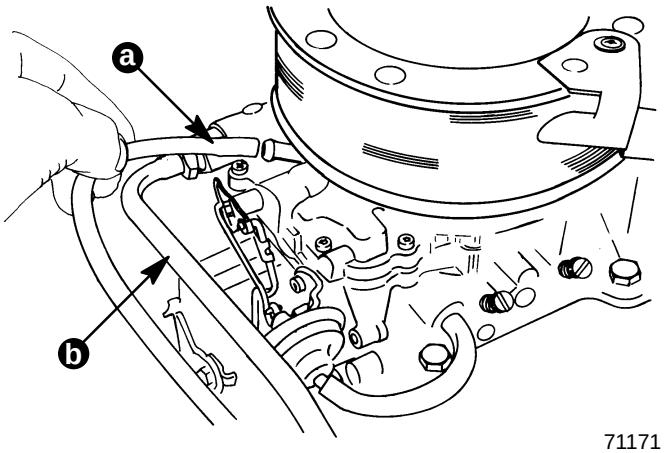
4. Install fuel line. To prevent over-tightening, hold fuel inlet filter nut with suitable wrench and tighten fuel line connector securely.



71173

a - Fuel Line
b - Fuel Inlet Filter Nut

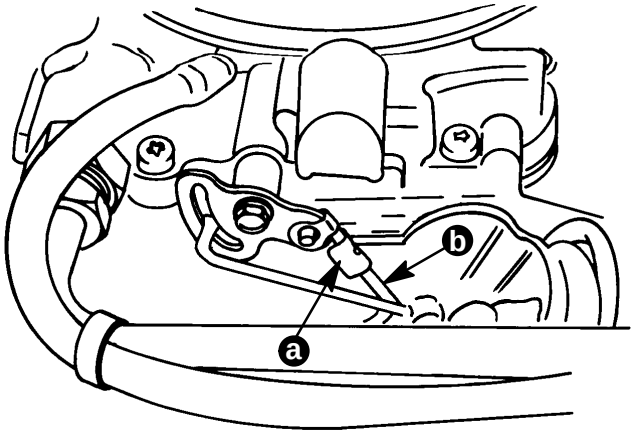
5. Connect fuel pump sight tube and fuel line.



71171

a - Fuel Pump Sight Tube
b - Fuel Line

6. Connect choke linkage rod and install retaining clip.



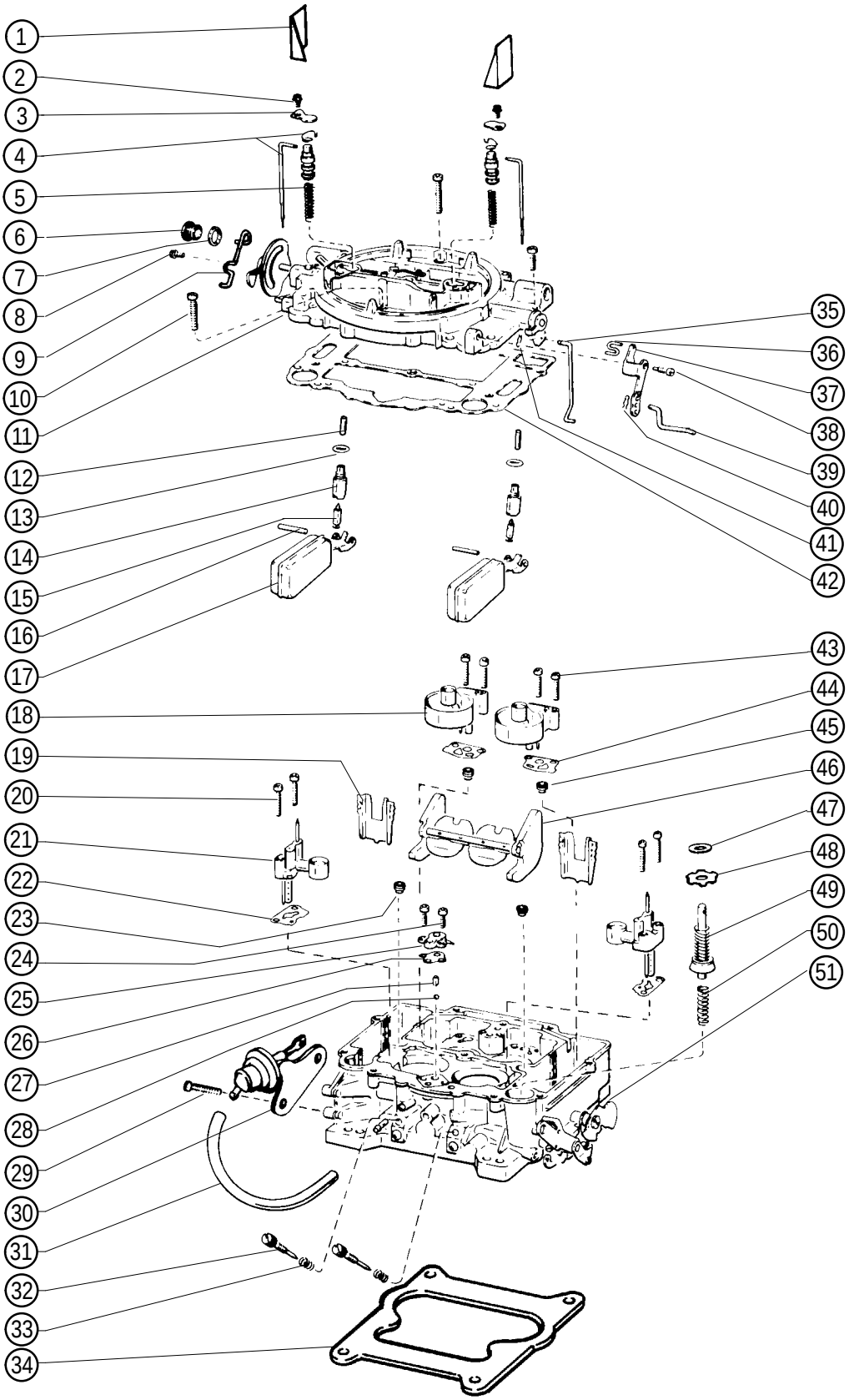
71096

a - Clip
b - Linkage Rod

7. Refer to Section 2. **Install and adjust** throttle cable following instructions appropriate to your power package.
8. Install flame arrestor and tighten nut securely.
9. Reconnect battery cables to battery by first installing positive battery cable to positive (+) battery terminal. Tighten clamp securely. Then, install negative battery cable to negative (–) battery terminal. Tighten clamp securely.
10. Turn on fuel supply at fuel tank.
11. Start engine and check for gasoline leaks. If leaks exist, **STOP ENGINE IMMEDIATELY** and recheck connections.
12. Adjust idle speed and idle mixture, as previously outlined under “Adjustments.”

Exploded View

Weber Carburetor



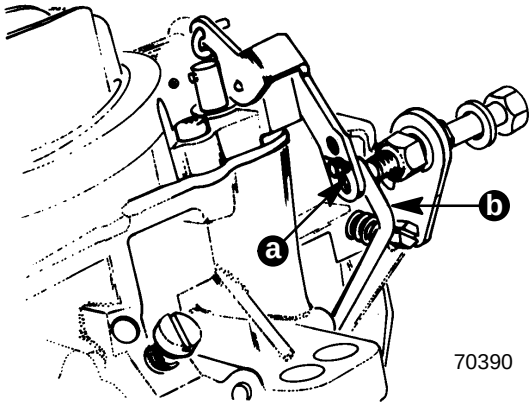
1-Air Deflector (2)
2-Screw (2)
3-Cover, Metering Rod (2)
4-Metering Rod Assembly (2)
5-Spring, Metering Rod (2)
6-Fuel Inlet Fitting
7-Sealing Washer
8-Screw
9-Linkage Rod, Choke Pull-Off
10- Screw
11- Air Horn (Carburetor Top)
12- Filter, Fuel Inlet (2)
13- Gasket (2)
14- Seat, Fuel Inlet (2)
15- Needle Valve, Fuel Inlet (2)
16- Pin (2)
17- Float (2)
18- Secondary Venturi Cluster (2)
19- Baffle Plate, Float Bowl (2)
20- Screw (4)
21- Primary Venturi Cluster (2)
22- Gasket (2)
23- Jet, Primary Fuel (2)
24- Screw (2)
25- Fuel Pump Injector Housing
26- Gasket
27- Check-Weight (or Check-Spring, if So Equipped)
28- Check-Ball
29- Screw
30- Diaphragm, Choke Pull-Off
31- Vacuum Hose
32- Idle Mixture Screw (2)
33- Spring, Idle Mixture Screw (2)
34- Gasket, Carburetor Base
35- Linkage Rod, Choke Plate
36- S-Link
37- Accelerator Pump Lever
38- Screw
39- Linkage Rod, Accelerator Pump
40- Wire Clip
41- Wire Clip
42- Gasket
43- Screw (4)
44- Gasket (2)
45- Jet, Secondary Fuel (2)
46- Secondary Air Valve and Weight Assembly
47- Plunger Washer
48- Plunger Guide
49- Accelerator Pump
50- Spring, Accelerator Pump
51- Float Bowl/Body (Carburetor Bottom)

Disassembly

The following is a step-by-step procedure for completely overhauling carburetor after removal from engine. In many cases, however, complete overhaul is not necessary and, in these cases, only the steps required to repair the carburetor malfunction should be performed. Read the instructions carefully to prevent doing unnecessary steps.

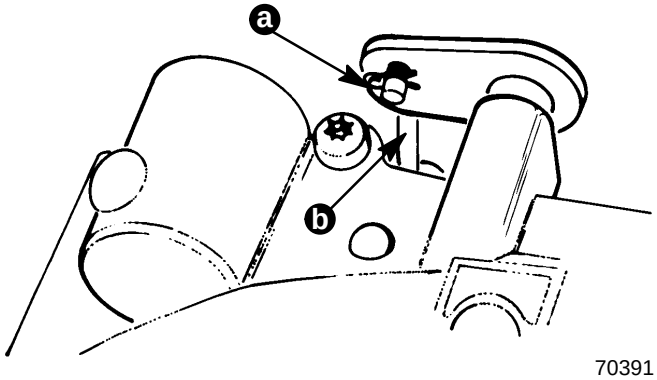
IMPORTANT: Before performing any service on carburetor, it is essential that carburetor be placed in a holding fixture to prevent possible damage to throttle valves.

1. Remove wire clip to disconnect accelerator pump linkage.

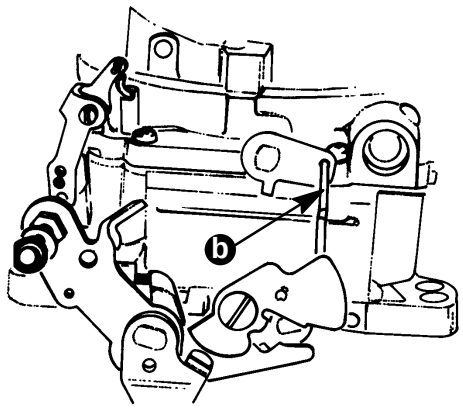


a - Wire Clip
b - Accelerator Pump Linkage Rod

2. Remove wire clip to disconnect choke plate linkage.



70391

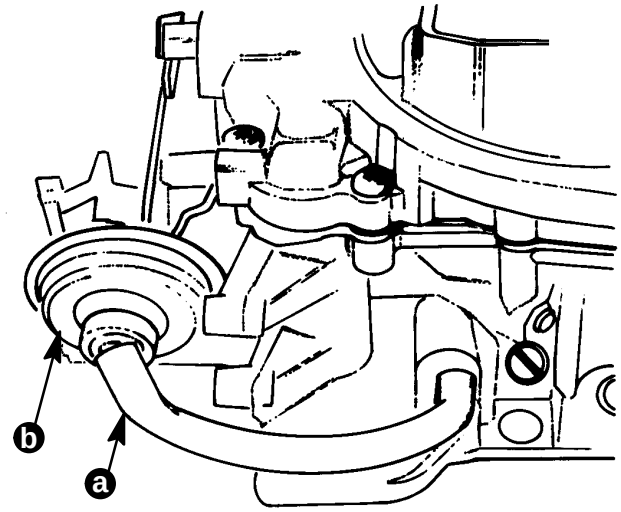


70392

a - Wire Clip
b - Choke Plate Linkage Rod

NOTE: *Do not remove vacuum hose if not servicing diaphragm.*

3. Disconnect vacuum hose from choke pull-off diaphragm.

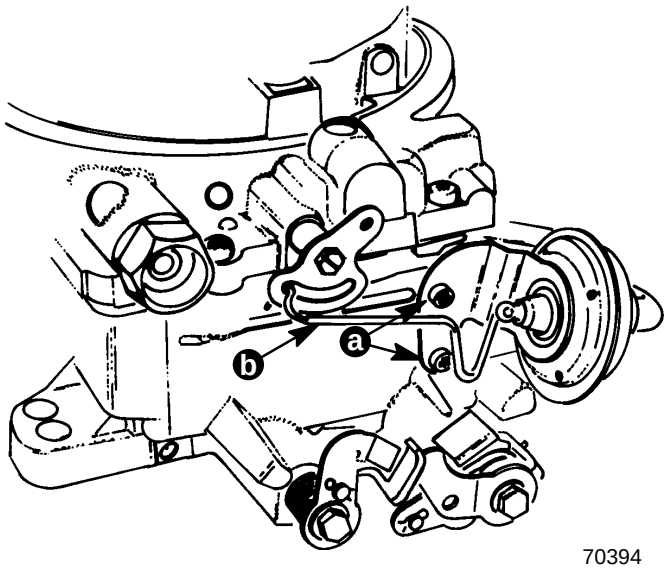


70393

a - Vacuum Hose
b - Choke Pull-Off Diaphragm

4. Remove screws from choke pull-off diaphragm bracket to disengage choke pull-off linkage.

NOTE: *Depending on amount of service required, it may not be necessary to remove diaphragm and bracket.*

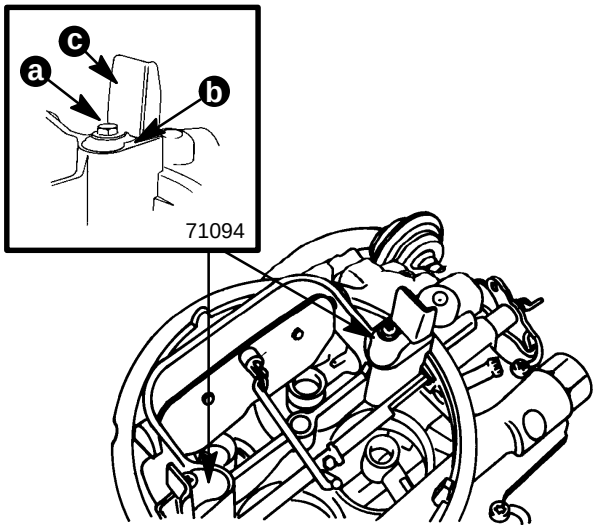


70394

a - Screws
b - Linkage Rod

IMPORTANT: Metering rods should always be removed before separating top and bottom halves of carburetor.

5. Loosen (not necessary to remove, depending on amount of service required) metering rod cover screws. Turn cover, or remove, to expose metering rod.

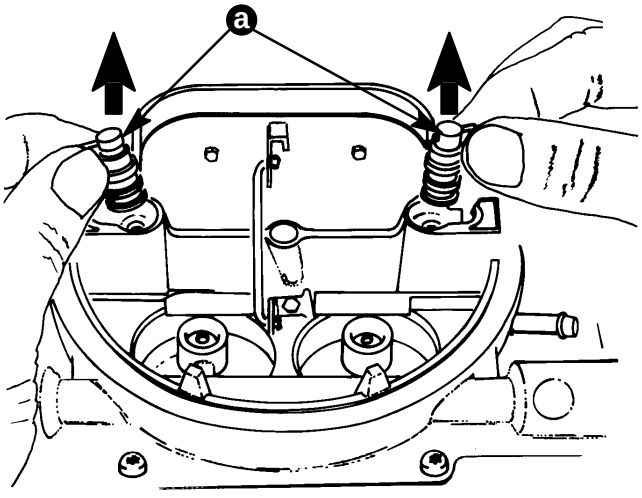


71095

a - Screws
b - Metering Rod Cover(s)
c - Air Deflectors If Equipped)

IMPORTANT: Be careful not to mix metering rods when removing them.

6. Carefully lift metering rod assemblies straight out.

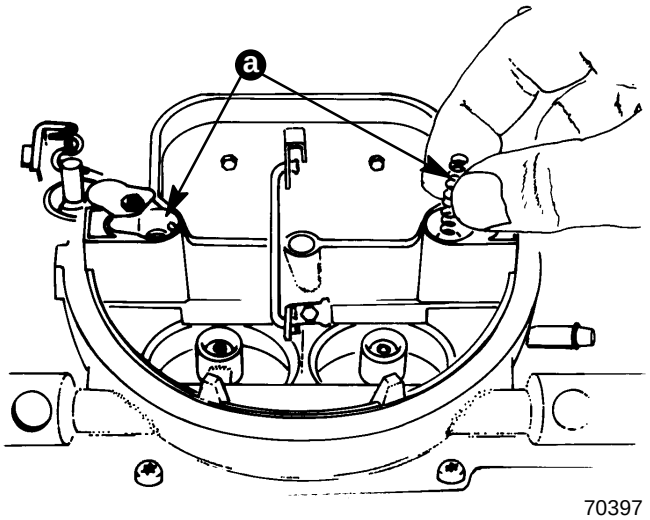


70396

a - Metering Rod Assembly(s)

7. Remove metering rod springs.

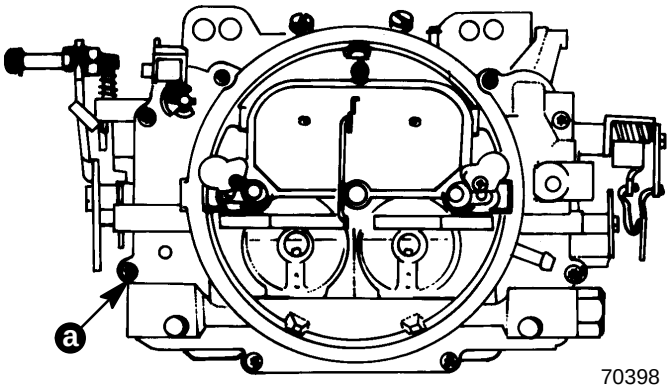
IMPORTANT: Metering rod springs are color coded and should not be interchanged with other carburetors.



70397

a - Spring(s)

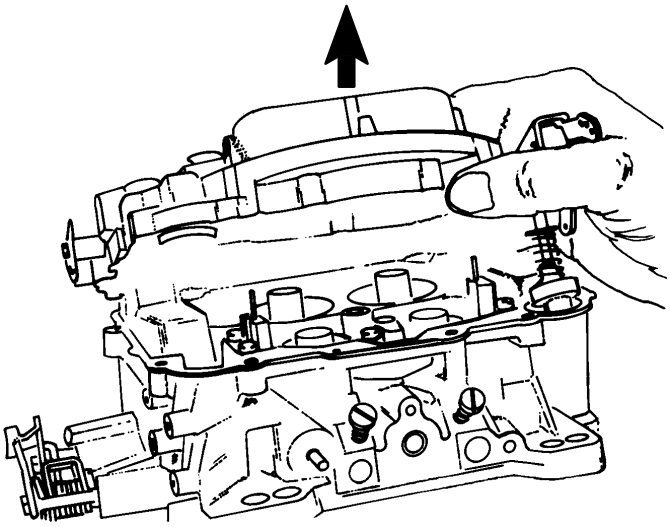
8. Remove nine screws to separate top and bottom halves of carburetor.



70398

a - Screw(s)

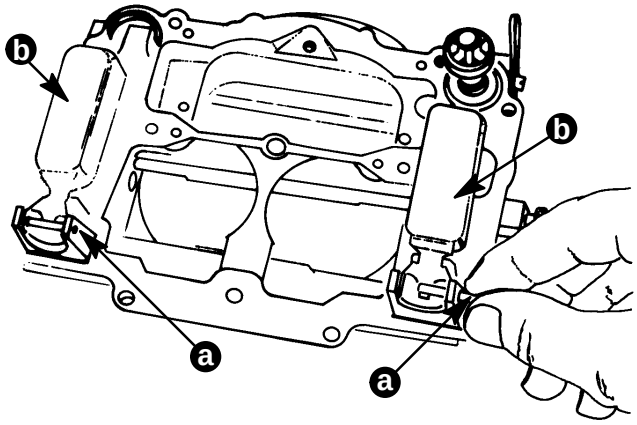
9. Carefully lift off carburetor top and disconnect choke linkage.



70399

10. Slide pin out to remove the float.

IMPORTANT: Be careful not to mix up floats after removal.

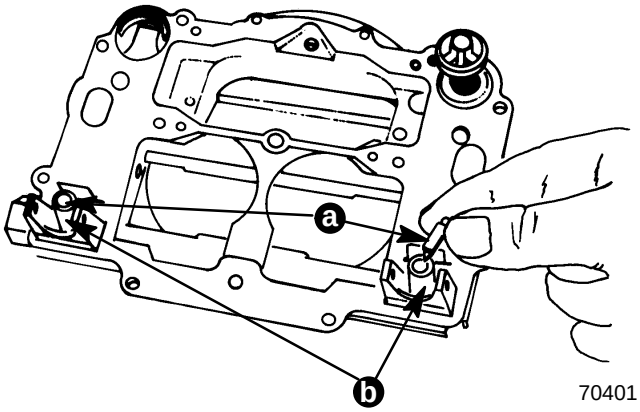


70400

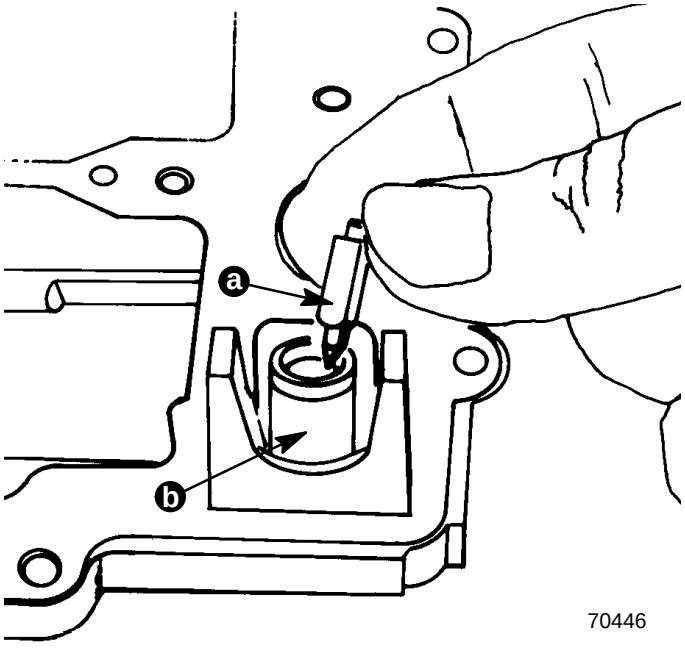
a - Pin(s)
b - Float(s)

11. Remove inlet needle from seat.

IMPORTANT: Be careful not to mix up inlet needles and seats after removal.



70401

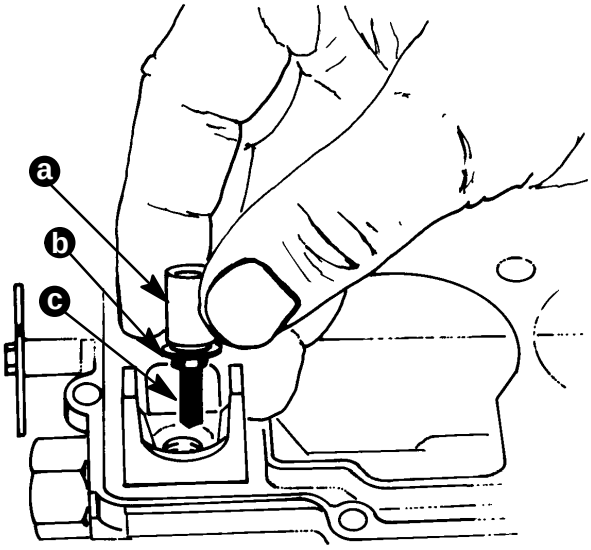


70446

a - Inlets Needle(s)
b - Seat(s)

12. Remove seat, gasket, and inlet filter.

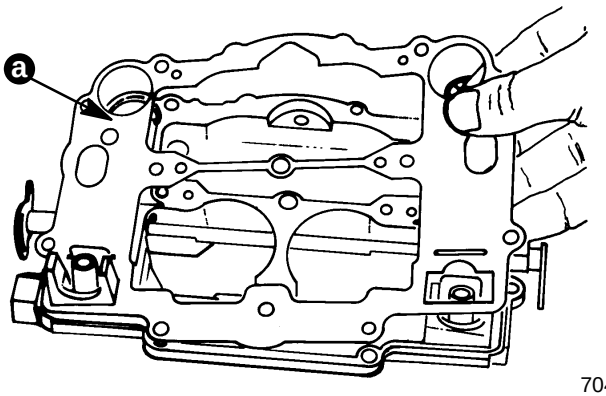
IMPORTANT: Be careful not to mix up seats after removal.



70447

a - Seat
b - Gasket
c - Inlet Filter

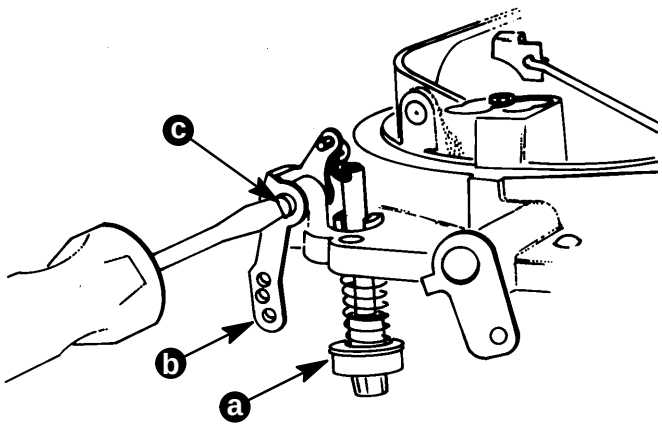
13. Remove gasket from top of carburetor.



70448

a - Gasket

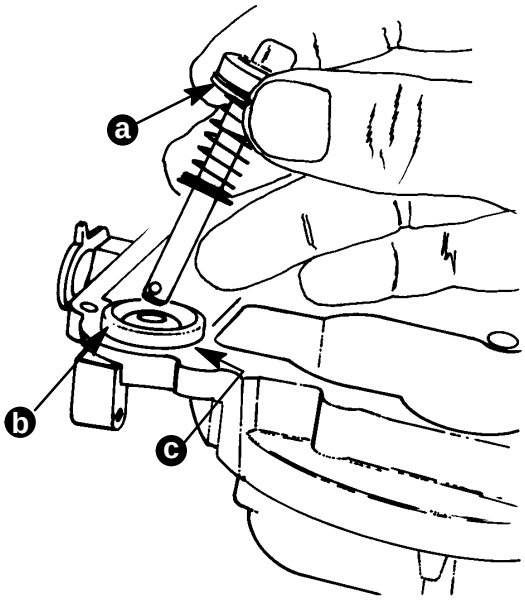
14. Remove accelerator pump lever.



70449

a - Accelerator Pump
b - Accelerator Pump Lever
c - Retaining Screw

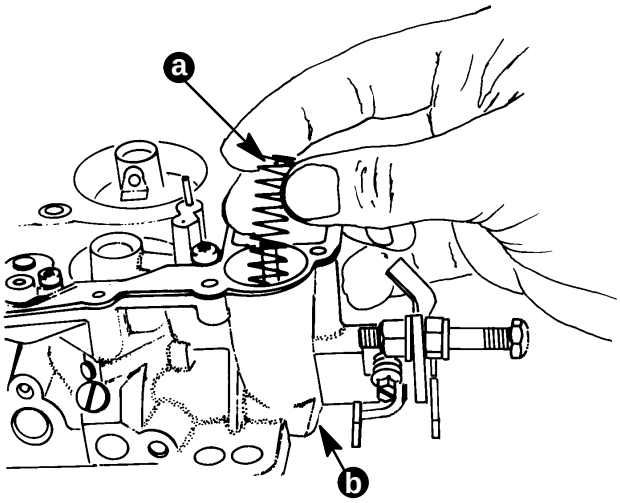
15. Remove accelerator pump.



70450

a - Accelerator Pump
b - Plunger Guide
c - Plunger Washer (Not Visible In This View)

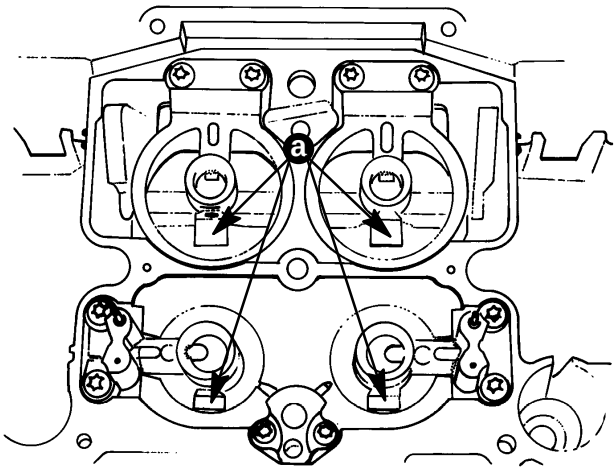
16. Remove accelerator pump spring from bottom half of carburetor.



70451

a - Accelerator Pump Spring
b - Carburetor Bottom

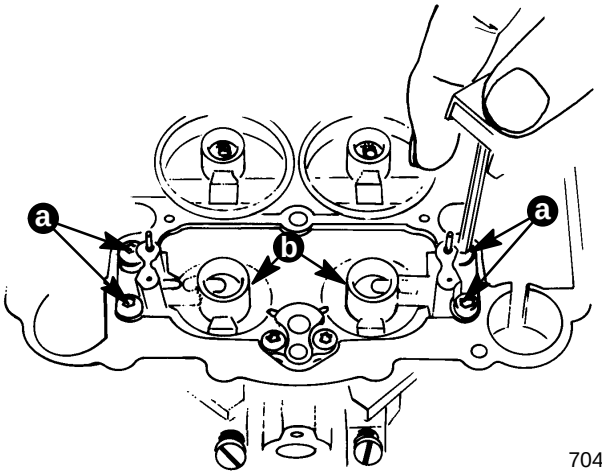
IMPORTANT: Before removing venturi clusters, it is important to note which clusters are equipped with a "distribution tab." This distribution tab arrangement varies from one carburetor to another.



70452

a - Distribution Tab(s) Location And Total Number May Vary

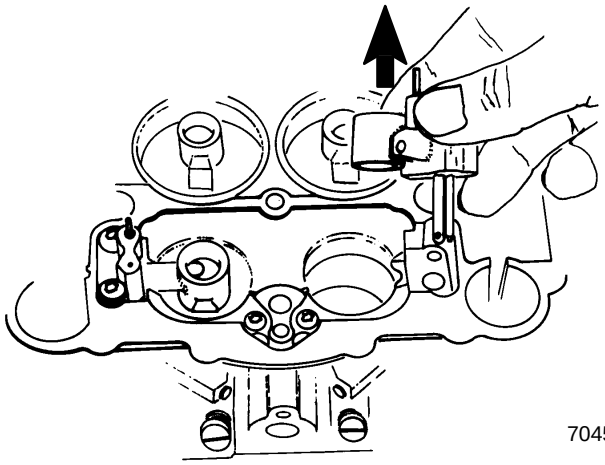
17. Remove two screws that secure primary venturi cluster.



70453

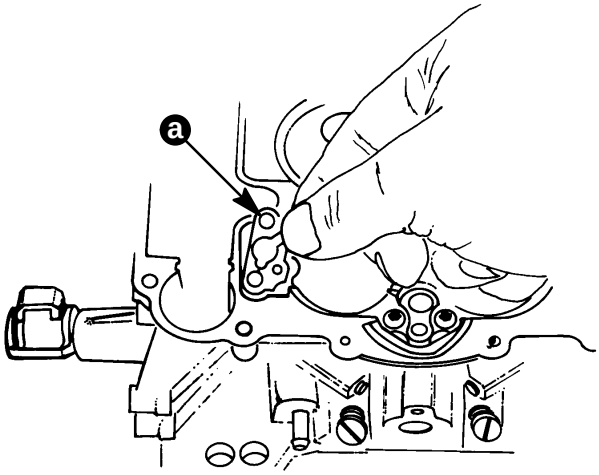
a - Screw(s) Two On Each Side
b - Primary Venturi Cluster(s)

18. Remove primary venturi cluster by lifting straight up.



70454

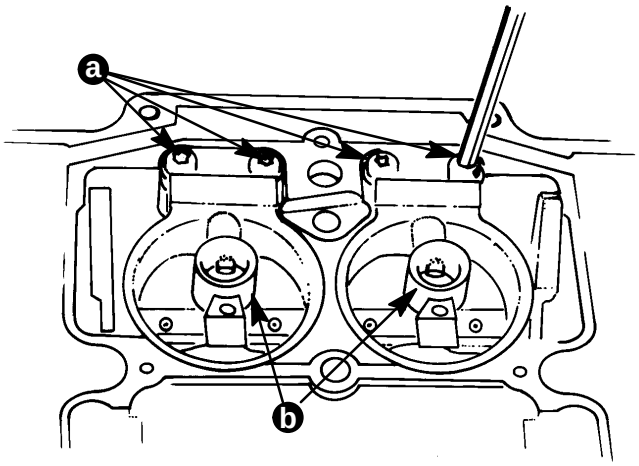
19. Remove gasket from beneath venturi cluster.



70455

a - Gasket Primary Venturi Cluster

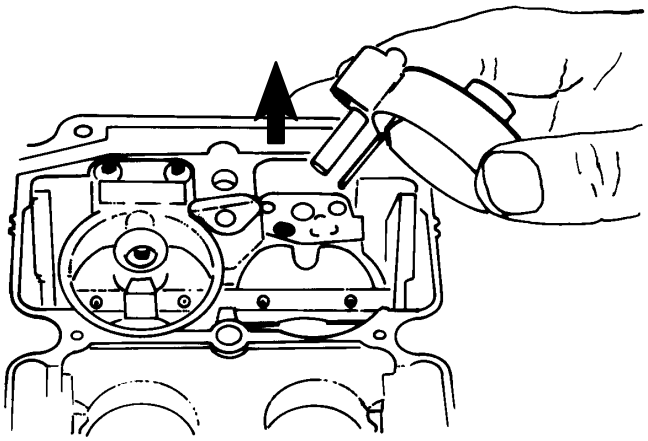
20. Remove two screws that secure secondary venturi clusters.



70456

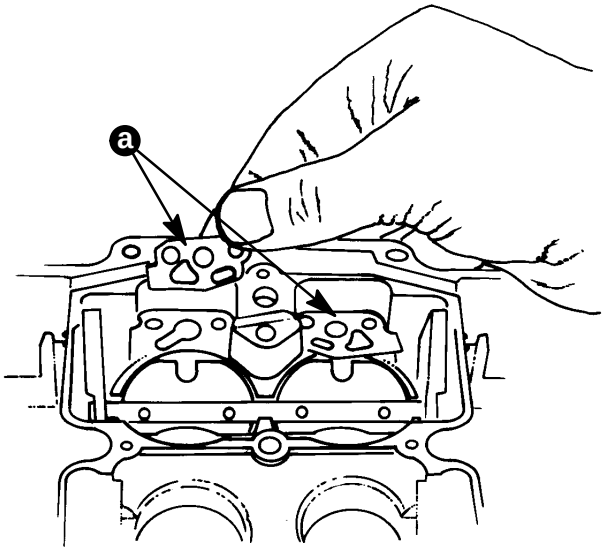
a - Screw(s) Two Each Side
b - Secondary Venturi Cluster(s)

21. Remove secondary venturi cluster by lifting it straight up.



70457

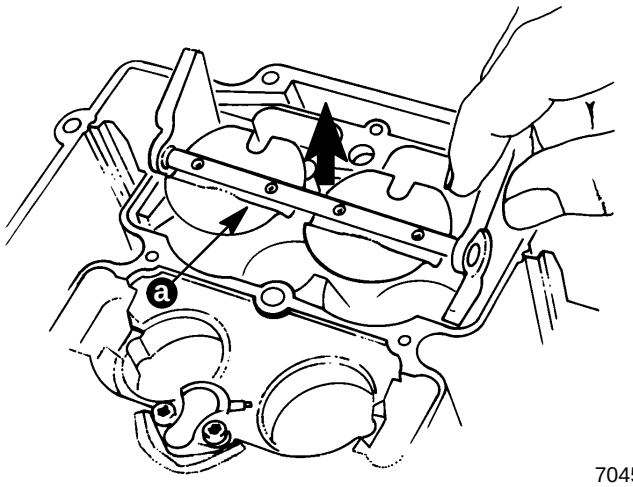
22. Remove gaskets from beneath secondary venturi clusters.



70458

a - Gasket, Secondary Venturi Cluster

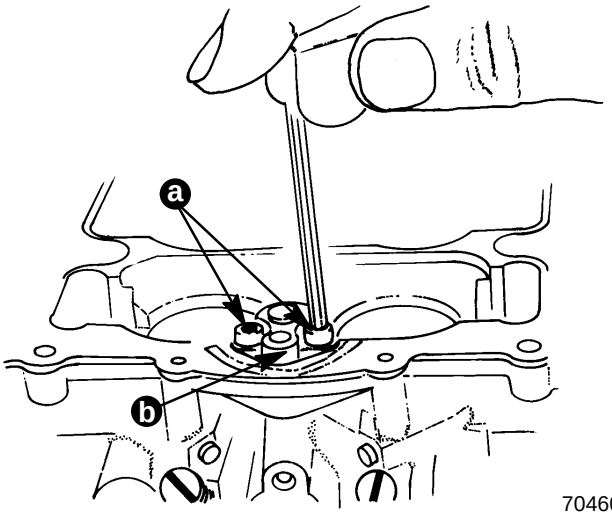
23. Remove secondary air valve and weight assembly by lifting it straight out.



70459

a - Secondary Air Valve And Weight Assembly

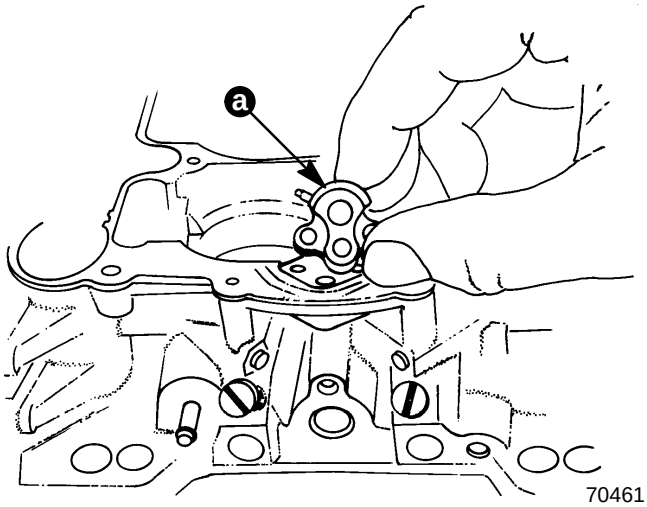
24. Remove two screws that secure pump jet housing.



70460

a - Screw(s)
b - Pump Jet Housing

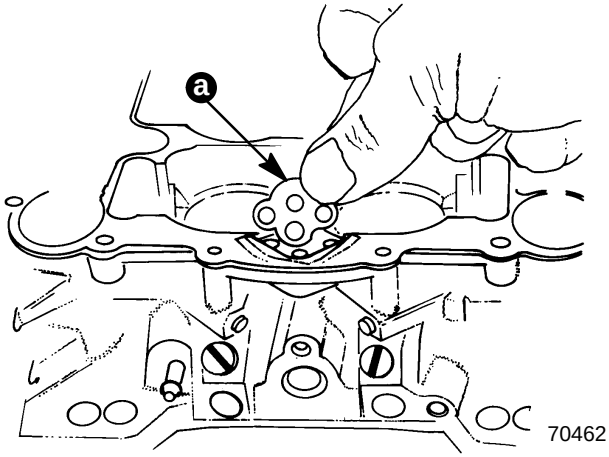
25. Remove pump jet housing.



70461

a - Pump Jet Housing

26. Remove gasket from beneath pump jet housing.

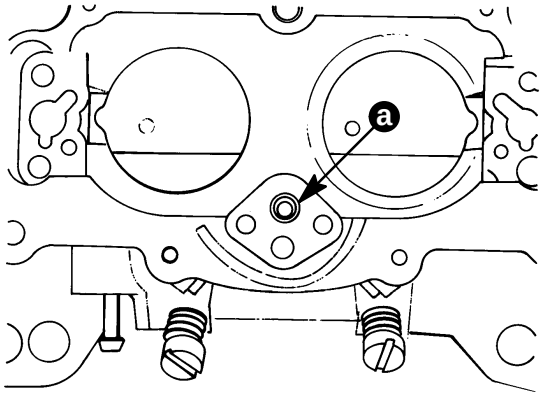


70462

a - Gasket, Pump Jet Housing

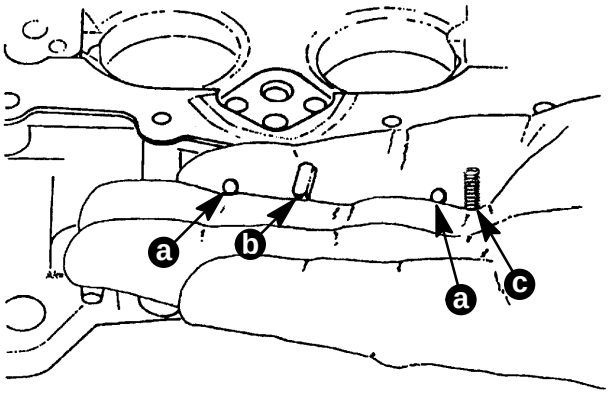
27. Remove check-ball and check-weight, or check-ball and check-spring, from hole beneath pump jet housing.

IMPORTANT: If your carburetor had a ball and weight combination, replace with ball and weight. If your carburetor used a ball and spring combination, replace with ball and spring.



70463

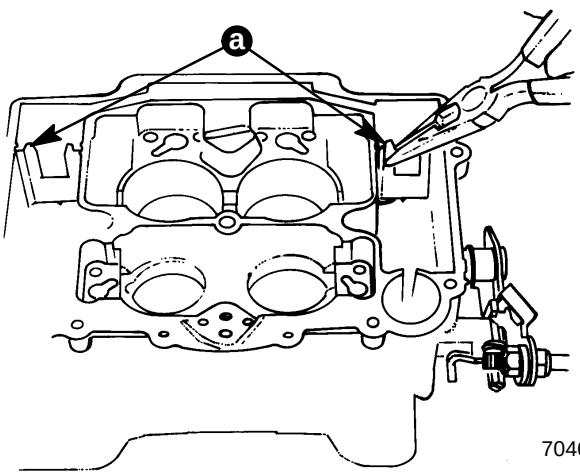
a - Ball Location



70464

a - Check Ball
b - Check Weight
c - Check Spring

28. Remove float bowl baffle plates, if necessary.



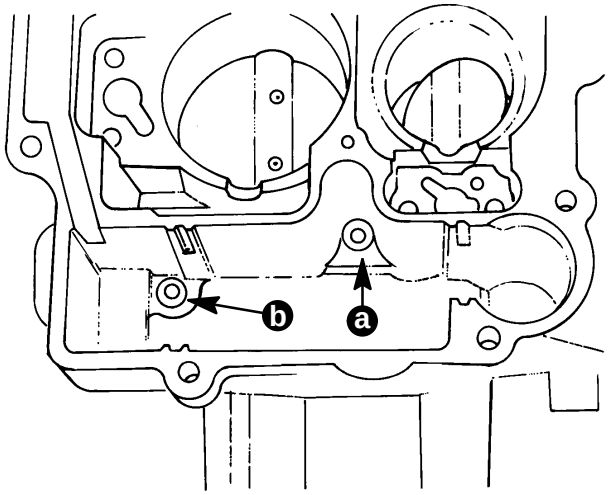
70465

a - Baffle Plate

IMPORTANT: Do not mix up the primary and secondary jets. Make note of the jet sizes and their location before removal to be certain that during reassembly they are installed in the carburetor side from which they were removed.

NOTE: *If jets are difficult to remove, place a screwdriver, with the correct width, in the jet slot and lightly tap the end of the screwdriver with a hammer.*

29. Remove primary and secondary jets.

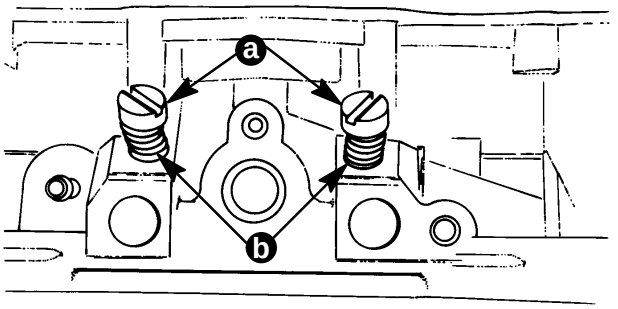


70466

a - Primary Fuel Jet
b - Secondary Fuel Jet

IMPORTANT: Before removing mixture screws, check and note the number of turns from the fully seated position. Also, do not mix up the two screws.

30. Remove mixture screws.



70467

a - Idle Mixture Screw
b - Spring, Idle Mixture Screw

Cleaning and Inspection

⚠CAUTION

Rubber, plastic parts, pump plungers or diaphragms cannot be immersed in carburetor cleaner.

⚠CAUTION

Avoid damage to carburetor. Do not leave carburetor in immersion-type cleaner for more than two hours.

IMPORTANT: Do not immerse metering rod springs in carburetor cleaner; the color, if not "natural" metal, may be removed. Clean separately as needed.

1. Clean metal carburetor parts in a commercial, immersion-type cleaner, until all deposits have been removed. Follow manufacturer's instructions of cleaner being used for proper cleaning and rinsing procedures.

⚠CAUTION

Avoid personal injury. Always wear safety glasses when using compressed air.

2. Blow out passages with compressed air. Do not drill through passages.

IMPORTANT: DO NOT use a wire or drill to clean jets, passages, or tubes in carburetor, as this may enlarge orifices and seriously affect carburetor calibration.

3. Wipe all parts that cannot be cleaned in immersion cleaner with a clean, dry cloth.
4. Carefully inspect all carburetor parts for damage or wear; pay particular attention to the following:
   a. **Idle mixture screws -** Replace if damaged or worn.
   b. **Fuel inlet needle valve and seat -** Replace with new needle and seat if worn or damaged.
   c. **Casting surfaces -** Inspect accelerator pump plunger well for scoring or deposits. Replace worn or corroded components.
   d. **All linkage rods and levers -** Replace if worn or damaged.
   e. **Accelerator pump and plunger parts -** Replace pump and parts if worn or damaged.
   f. **Float assembly and hinge pin -** Float weight of each should be the same. Replace either if fuel can be heard inside when shaken. Check hinge pin and holes for wear. Replace components if worn or defective.
   g. **Throttle valves and shafts -** Check for binding (through entire operating range, making sure valves open and close completely) or for looseness in carburetor body.

IMPORTANT: DO NOT remove throttle valves. If any of the throttle parts or float bowl/carburetor body shaft bores are found to be worn or damaged, carburetor replacement is required.

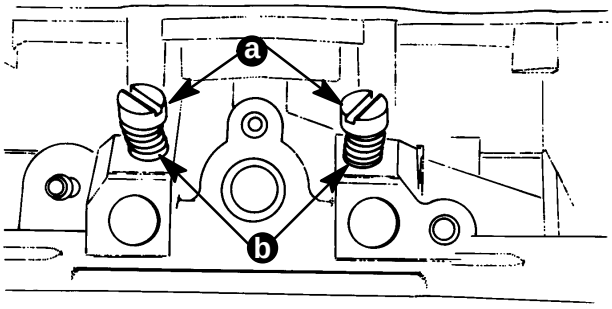
   h. **Choke valve and shaft/lever assembly -** Check shaft and lever for excessive looseness in air horn. Check choke valve and shaft/lever assembly for binding through entire operating range. Air horn assembly must be replaced if choke valve and shaft/lever are worn.

5. Check that choke pull-off diaphragm plunger retracts when vacuum is applied to unit, and that it holds vacuum (plunger remains seated if vacuum is maintained).

Reassembly

1. Install mixture screws (needles) with springs in place. Turn idle mixture screws in (clockwise) until LIGHTLY seated, then back out one and quarter (1-1/4) turns if previous settings were not noted on disassembly.

IMPORTANT: Do not turn idle mixture screws tightly against seat, as damage to seat and/or needle may result.

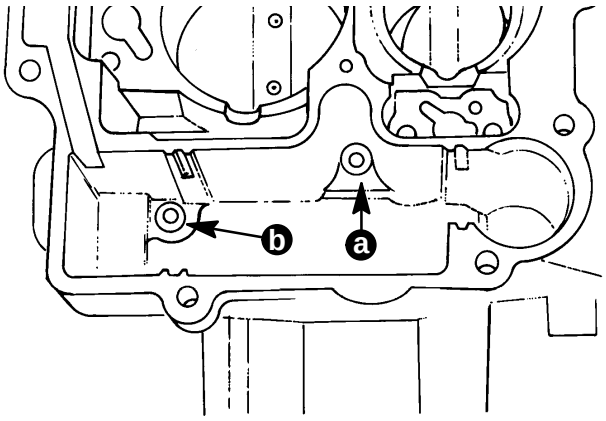


70467

a - Idle Mixture Screw
b - Spring, Idle Mixture Screw

2. Install the primary and secondary jets. Tighten only till snug.

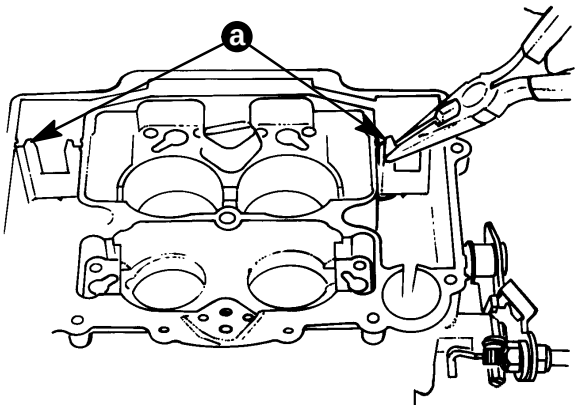
IMPORTANT: Be sure that primary and secondary jets are installed in the appropriate location. Be sure that the size matches the same size recorded during disassembly.



70466

a - Primary Fuel Jet
b - Secondary Fuel Jet

3. Install the float bowl baffle plates, if previously removed.

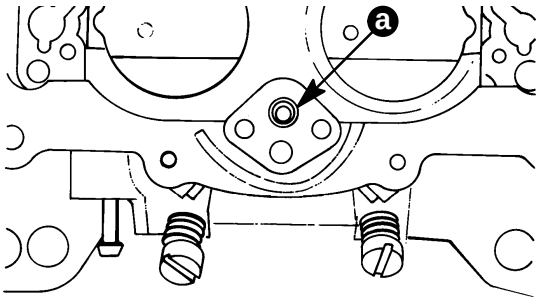


70465

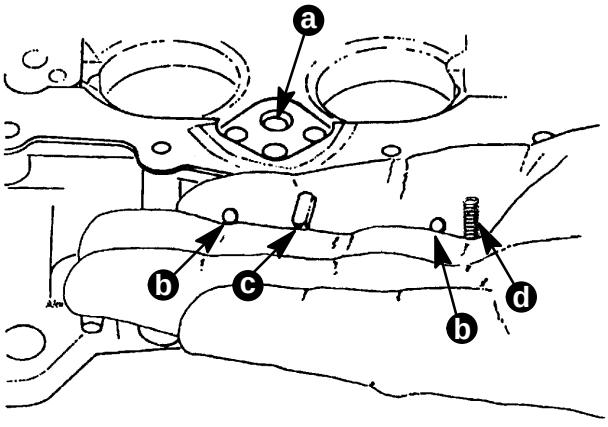
c - Baffle Plate

4. Into bore beneath pump jet housing location, install check-ball and then check-weight or, if so equipped, check-ball and check-spring.

IMPORTANT: If your carburetor had a ball and weight combination, replace with ball and weight. If your carburetor used a ball and spring combination, replace with ball and spring.



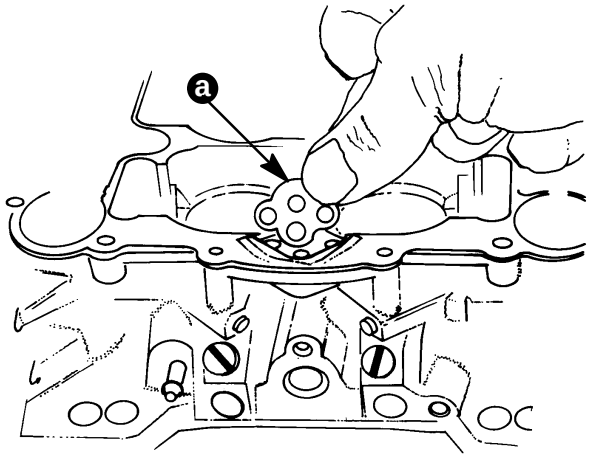
70463



70464

a - Bore
b - Check Ball
c - Check Weight
d - Check Spring

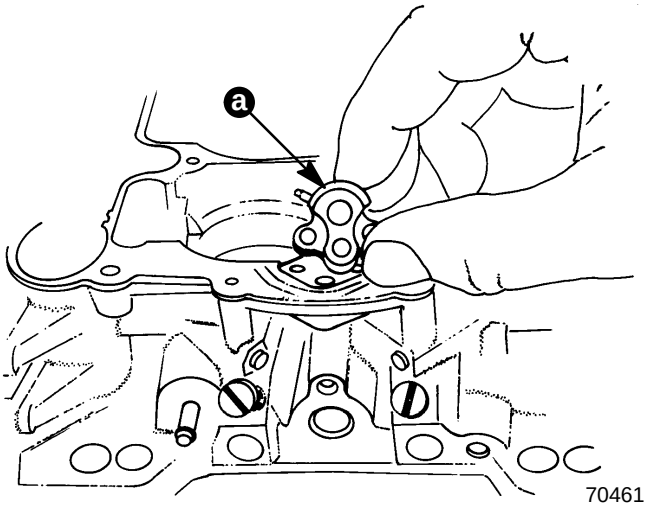
5. Position pump jet housing gasket.



70462

a - Gasket, Pump Jet Housing

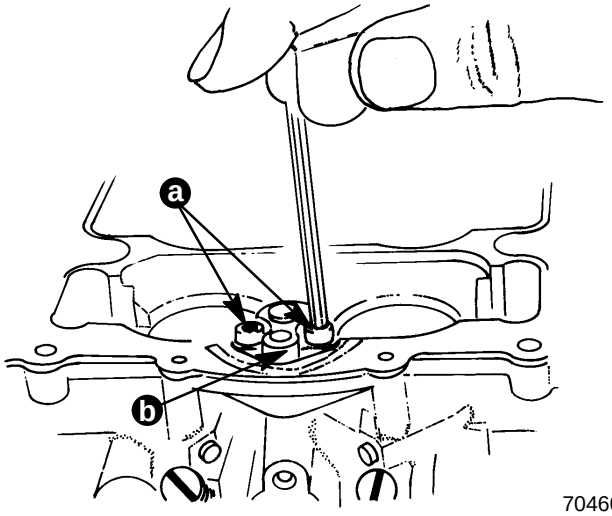
6. Install pump jet housing.



70461

a - Pump Jet Housing

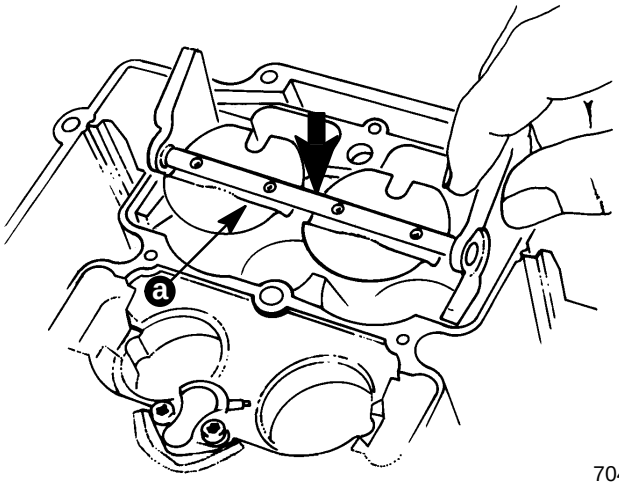
7. Install two screws that secure pump jet housing. Tighten securely.



70460

a - Screws
b - Pump Jet Housing

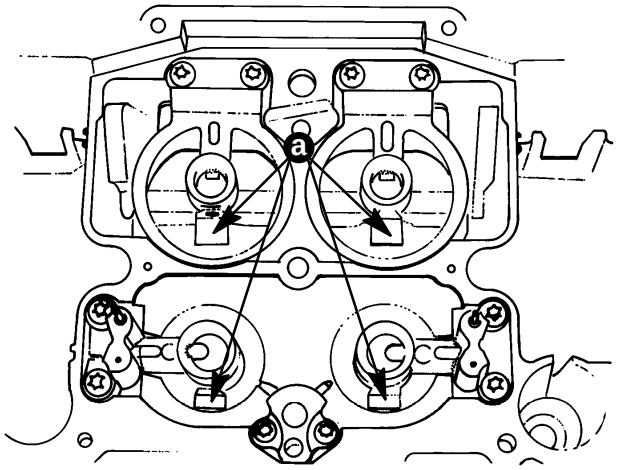
8. Install the secondary air valve and weight assembly.



70459

a - Secondary Air Valve And Weight Assembly

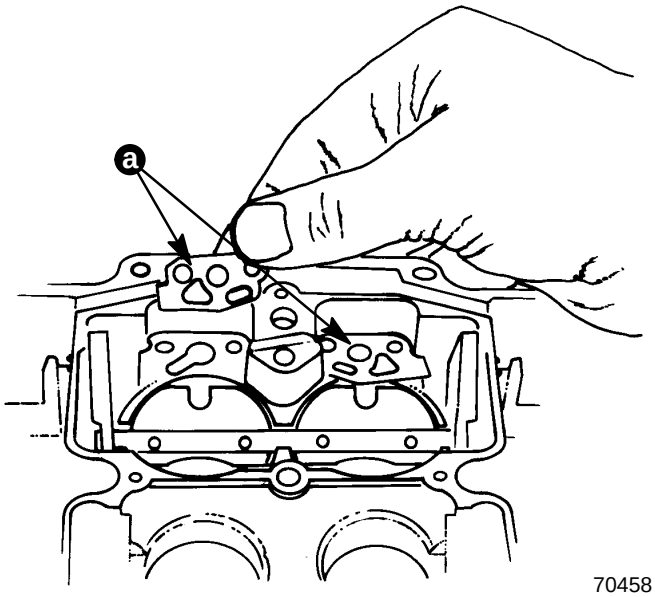
IMPORTANT: Before installing venturi clusters, it is important to note which clusters were equipped with a "distribution tab." This distribution tab arrangement varies from one carburetor to another.



70452

a - Distribution Tab(s) Location And Total Number May Vary

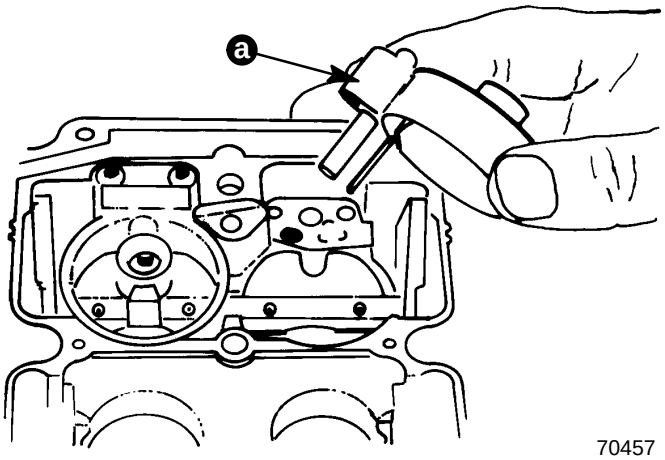
9. Position the secondary venturi cluster gaskets.



70458

a - Gasket, Secondary Venturi Cluster

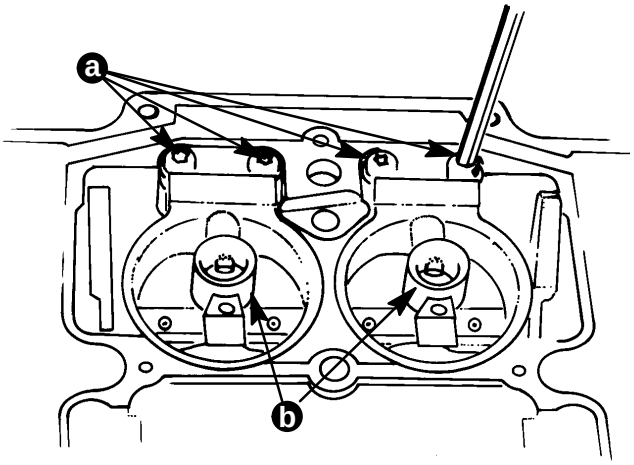
10. Install the secondary venturi clusters.



70457

a - Secondary Venturi Cluster

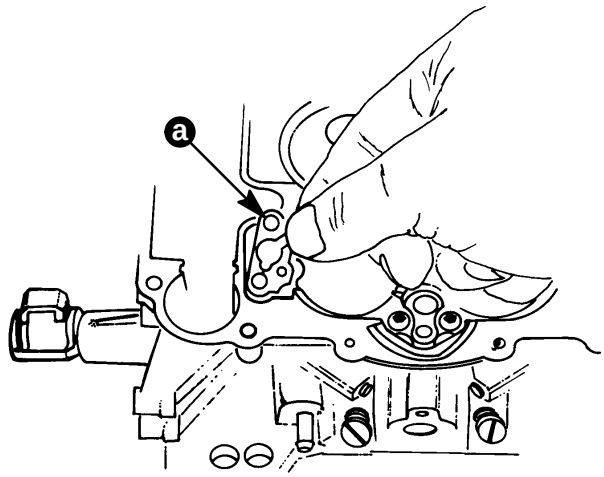
11. Secure each cluster with two screws. Tighten securely.



70456

a - Screws (Two On Each Side)
b - Secondary Venturi Cluster(s)

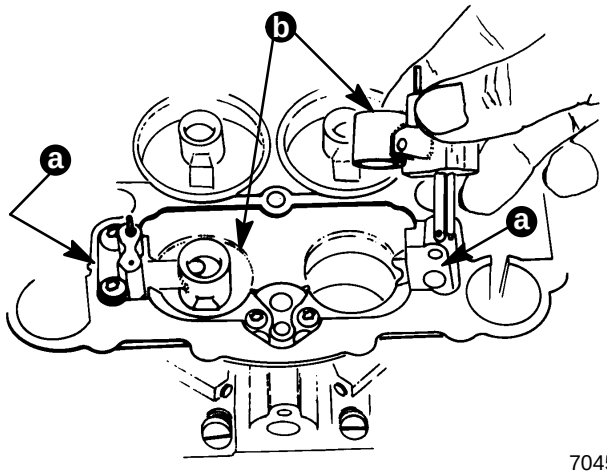
12. Position the primary venturi cluster gaskets.



70455

a - Gasket, Primary Venturi Cluster

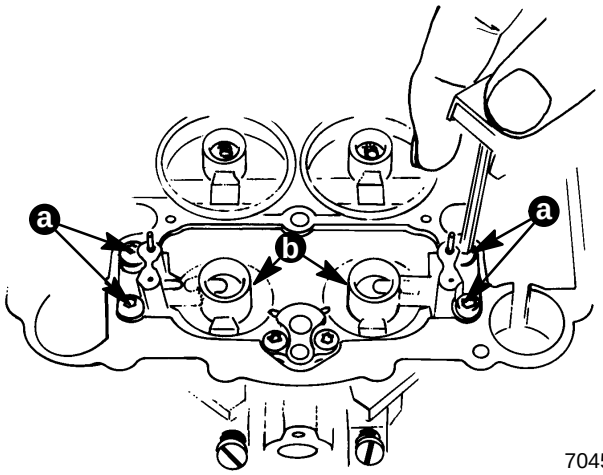
13. Install the primary venturi clusters.



70454

a - Gasket, Primary Venturi Cluster (One Not N+Visible In This View)
b - Primary Venturi Cluster

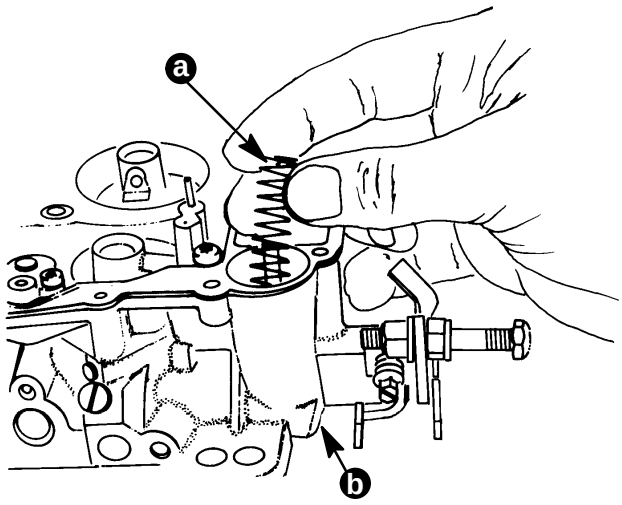
14. Secure each cluster with two screws. Tighten securely.



70453

a - Screws (Two Each Side)
b - Primary Venturi Cluster(s)

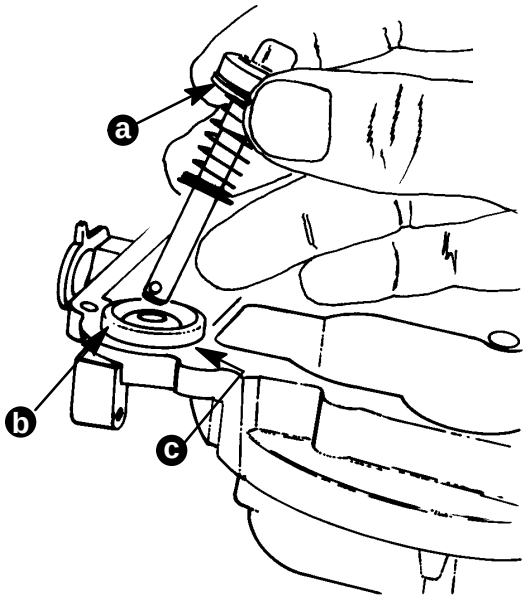
15. Install the accelerator pump spring into bottom half of carburetor.



70451

a - Accelerator Pump Spring
b - Carburetor Bottom

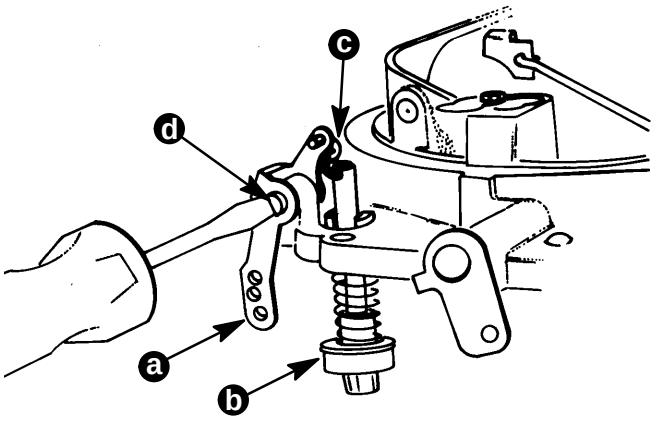
16. Install accelerator pump in top of carburetor housing, after placing washer and guide in position.



70450

a - Accelerator Pump
b - Plunger Guide
c - Plunger Washer (Not Visible In This View)

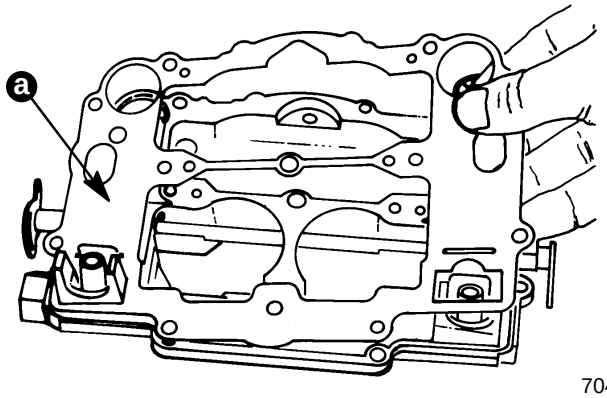
17. Connect accelerator pump lever to pump rod using the S-link. Secure pump lever with pivot screw. Tighten securely. Check to ensure lever actuates the accelerator pump.



70449

a - Accelerator Pump Lever
b - Accelerator Pump
c - S-Link
d - Retainer Screw

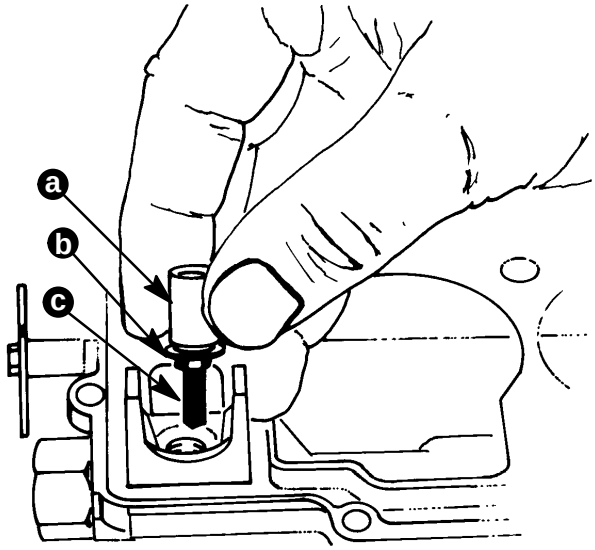
18. Install gasket on top of carburetor.



70448

a - Gasket

19. Install inlet filter in bottom of inlet seat. Install inlet seat with gasket in place. Tighten securely.

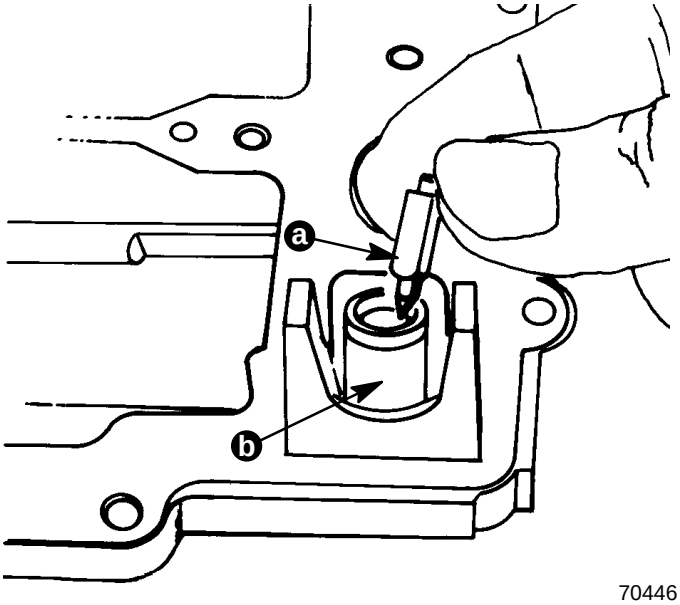


70447

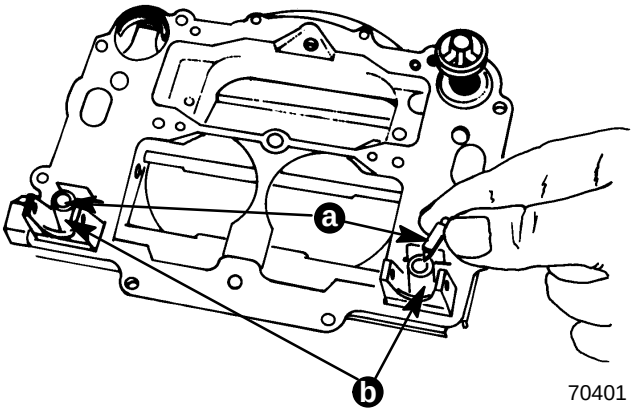
a - Seat
b - Gasket
c - Inlet Filter

IMPORTANT: If using existing needles and seats, be sure to reinstall them as matched sets, as noted during disassembly.

20. Install appropriate inlet needles into inlet seats.



70446

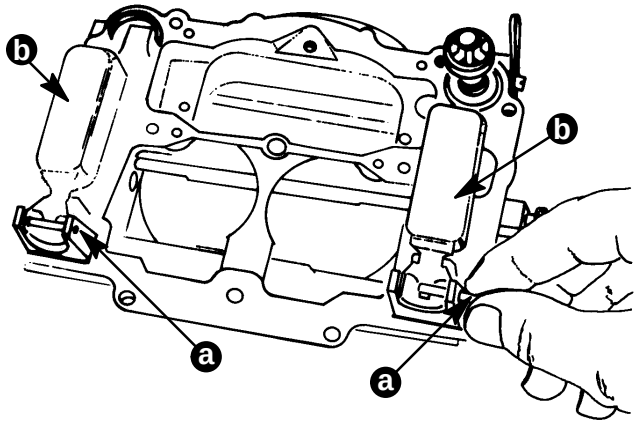


70401

a - Inlet Needle(s)
b - Seat(s)

IMPORTANT: If using existing floats, be sure to reinstall them on the same side as removed.

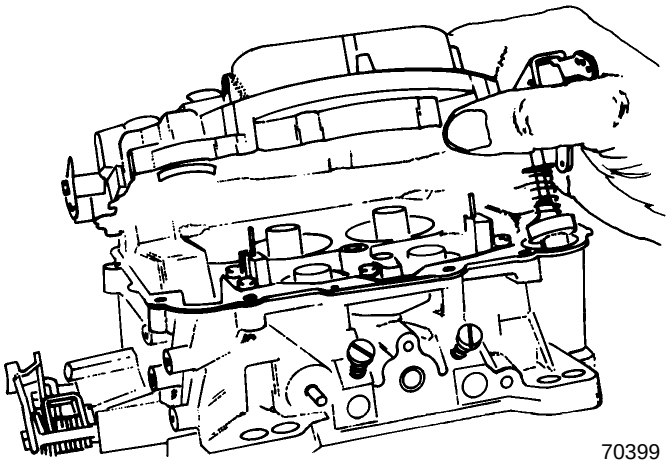
21. Install floats using hinge pins.



70400

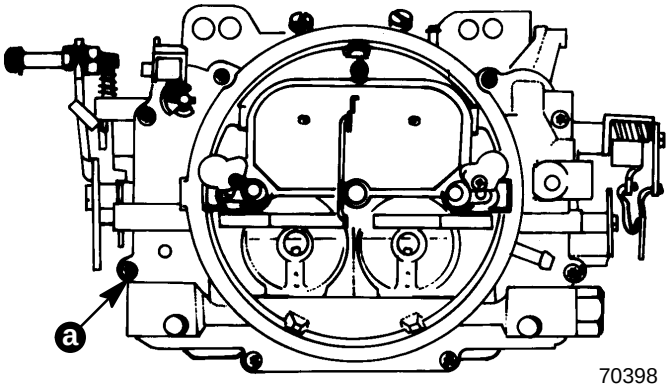
a - Pin(s)
b - Floats(s)

22. Carefully lower top of carburetor onto bottom part.



70399

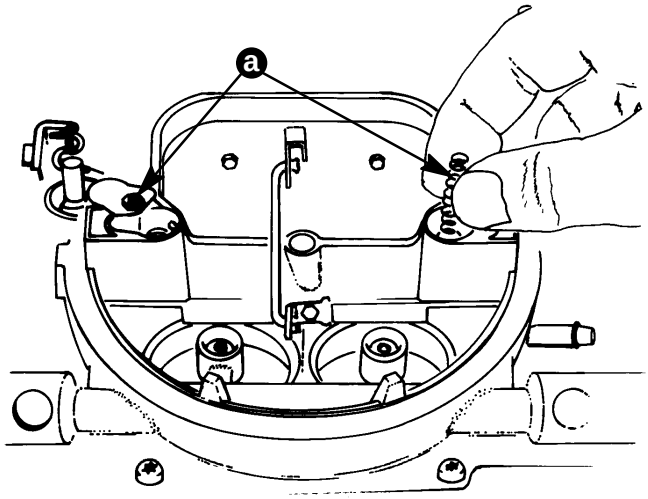
23. Ensure gasket is properly positioned between the two parts and secure the top to bottom with screws (nine total). Tighten securely.



70398

a - Screw(s)

24. Install metering rod springs into each metering rod hole. Be certain to install the appropriate color spring (refer to “Specifications”).

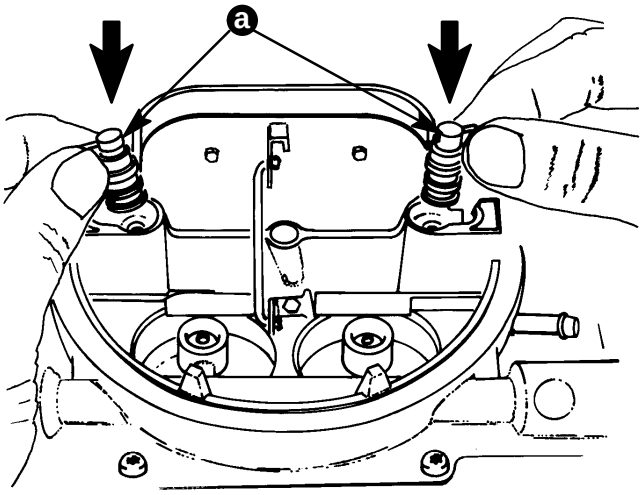


70397

a - Spring(s)

IMPORTANT: If using existing metering rods, be sure that they are reinstalled in the same side from which removed during disassembly.

25. Carefully install metering rod assemblies in the appropriate holes. Push down lightly on metering rods to ensure that plunger will spring up and down.

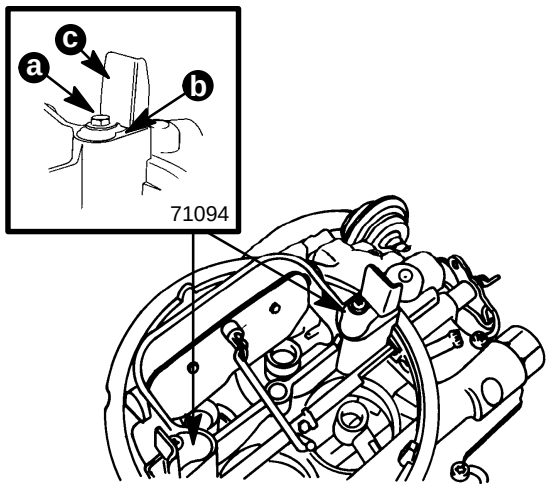


70396

a - Metering Rod Assembly(s)

IMPORTANT: Some carburetors are equipped with air deflectors that are attached to the screw that holds down the metering rod covers. Be sure to reinstall the deflectors if your model carburetor requires them.

26. Position metering rod covers (and air deflectors, if equipped) over metering rods and install screws. Tighten securely.

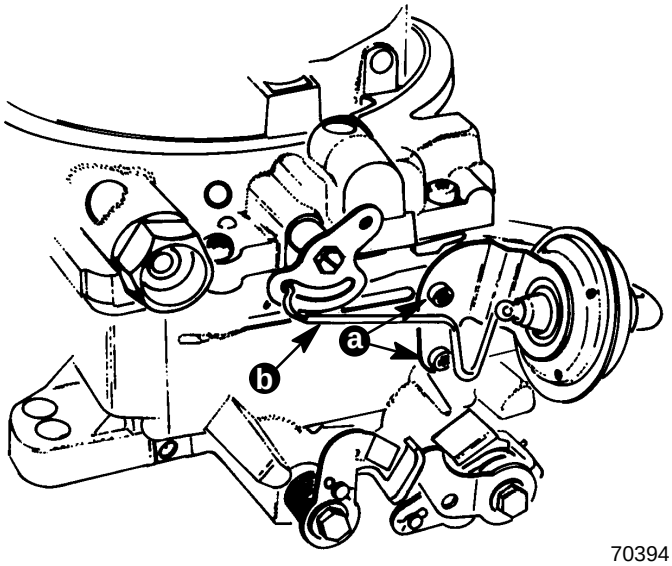


71094

71095

a - Screws
b - Metering Cover(s)
c - Air Deflectors (If Equipped)

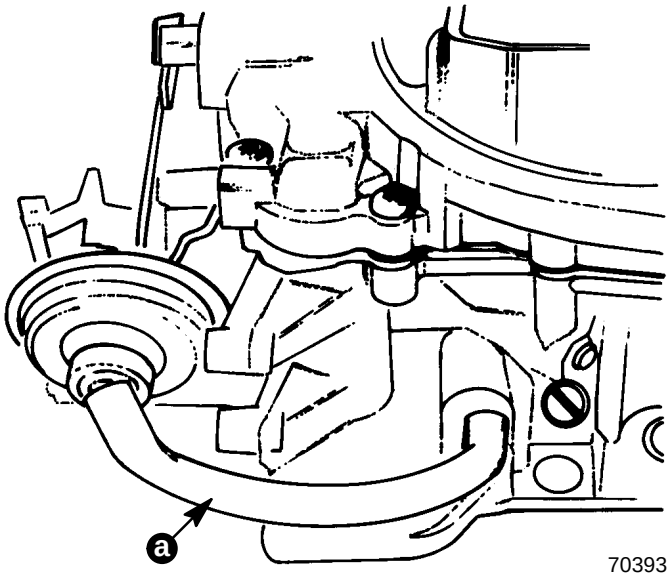
27. Reconnect choke pull-off linkage to carburetor. Reinstall choke pull-off diaphragm. Secure with two screws and tighten securely.



70394

a - Screw(s)
b - linkage Rod

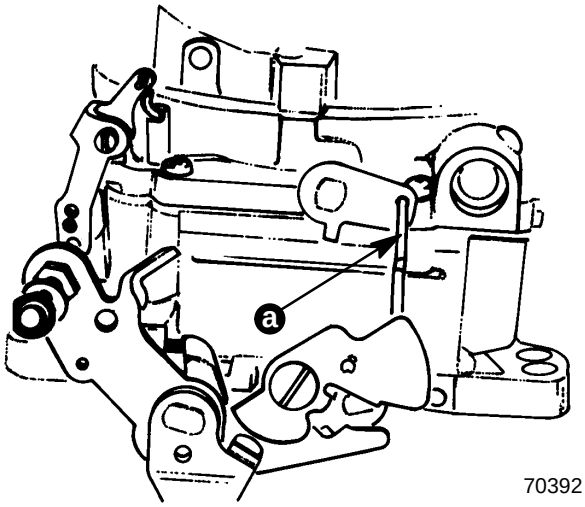
28. Reconnect vacuum hose to choke pull-off diaphragm.



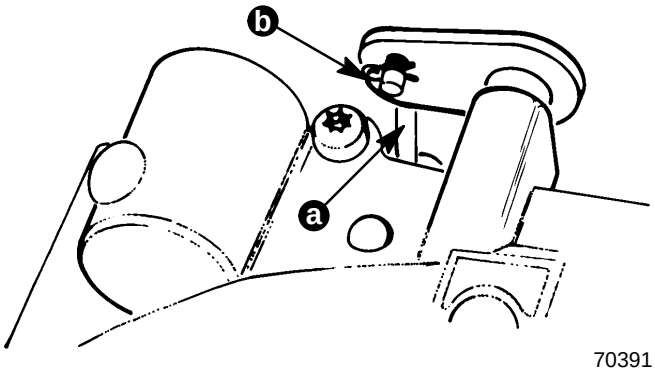
70393

a - Vacuum Hose

29. Reconnect choke plate linkage. Secure with wire clip.



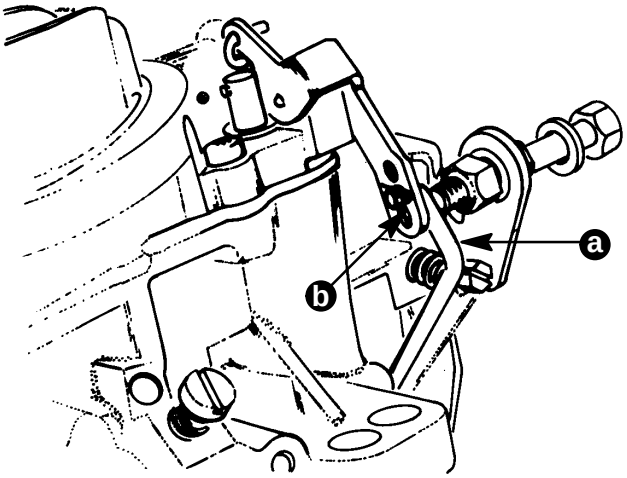
70392



70391

a - Choke Plate Linkage Rod
b - Wire Clip

30. Reconnect accelerator pump linkage rod to hole in accelerator pump lever where originally connected or refer to “Important Service Information” in this section for information regarding adjustment. Accelerator pump linkage adjustment should be checked at this time; refer to Adjustments - “Accelerator Pump” as previously outlined. Secure using wire clip.



70390

a - Accelerator Pump Linkage Rod
b - Wire Clip

31. Refer to “Installation” and install carburetor.

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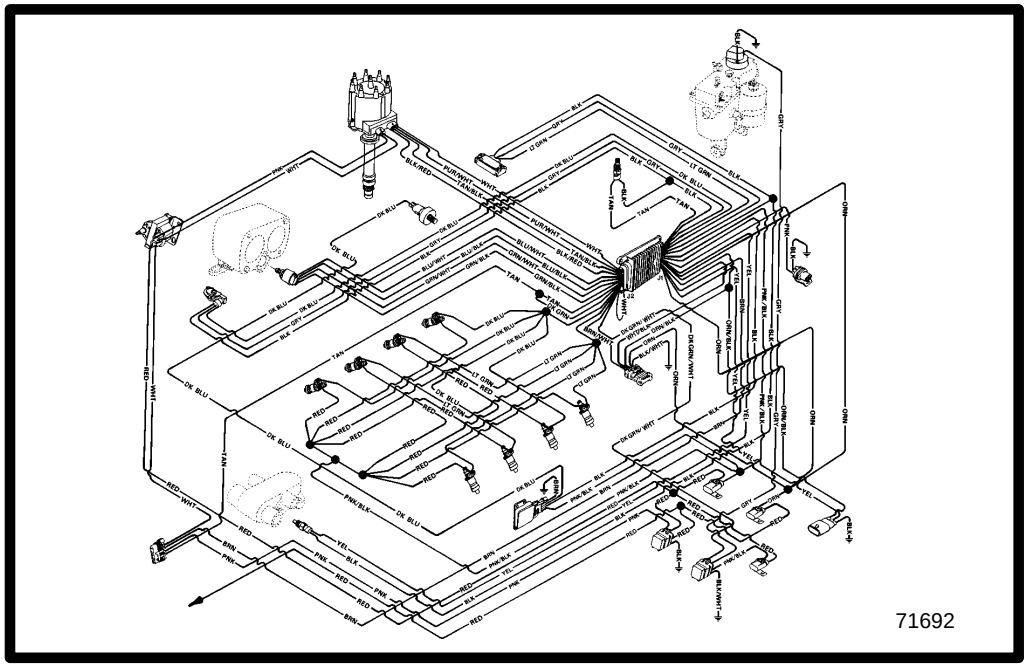
THIS PAGE IS INTENTIONALLY BLANK TO ALLOW FOR CORRECTIONS OR ADDITIONS AT A LATER DATE

FUEL SYSTEMS



5
C

MULTI-PORT AND THROTTLE BODY FUEL INJECTION

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General Information

⚠ CAUTION

To reduce the chance of personal injury and/or property damage, the following instructions must be carefully observed: proper service and repair are important to the safety of the service technician and the safe, reliable operation of all MerCruiser Electronic Fuel Injection (Multi-Port And Throttle Body) equipped engines. If part replacement is necessary, the part must be replaced with one of the same part number or with an equivalent part. Do not use a replacement part of lesser quality. The service procedures recommended and described in this service manual are effective methods of performing service and repair. Some of these procedures require the use of tools specially designed for the purpose. Accordingly, anyone who intends to use a replacement part, service procedure or tool, which is not recommended by the system manufacturer, must first determine that neither his safety nor the safe operation of the engine will be jeopardized by the replacement part, service procedure or tool selected. It is important to note that this manual contains various "Cautions" and "Notes" that must be carefully observed in order to reduce the risk of personal injury during service or repair, or the possibility that improper service or repair may damage the engine or render it unsafe. It is also important to understand that these "Cautions" and "Notes" are not exhaustive, because it is impossible to warn of all the possible hazardous consequences that might result from failure to follow these instructions.

Introduction

The following manual has been prepared for effective diagnosis of the MerCruiser Electronic Fuel Injection system.

All information, illustrations and specifications contained in this manual are based on the latest product information available at the time of publication approval. The right is reserved to make changes at any time without notice.

An understanding of the material contained herein and in subsequent publications issued when necessary, will assist service personnel in properly maintaining the quality to which MerCruiser engine control systems are built.

Visual/Physical Inspection

A careful visual and physical inspection must be performed as part of any diagnostic procedure. This can often lead to fixing a problem without further steps. Inspect all vacuum hoses for correct routing, pinches, cuts, or disconnects. Be sure to inspect hoses that are difficult to see. Inspect all the wires in the engine compartment for proper connections, burned or chafed spots, pinched wires, or contact with sharp edges or hot exhaust manifolds. This visual/physical inspection is very important. It must be done carefully and thoroughly.

Basic Knowledge and Tools Required

To use this manual most effectively, a general understanding of basic electrical circuits and circuit testing tools is required. You should be familiar with wiring diagrams; the meaning of volts, ohms and amperes; the basic theories of electricity; and understand what happens in an open or shorted wire. To perform system diagnosis, several special tools and equipment are required. Please become acquainted with the tools and their use before attempting to diagnose the system. Special tools which are required for system service are listed later in this section (see "Table of Contents").

Electrostatic Discharge Damage

Electronic components used in control systems are often designed to carry very low voltage, and are very susceptible to damage caused by electrostatic discharge. It is possible for less than 100 volts of static electricity to cause damage to some electronic components. By comparison, it takes 4,000 volts for a person to even feel the effect of a static discharge.

There are several ways for a person to become statically charged. The most common methods of charging are by friction and by induction. An example of charging by friction is a person sliding across a seat, in which a charge of as much as 25,000 volts can build up. Charging by induction occurs when a person with well-insulated shoes stands near a highly charged object and momentarily touches ground. Charges of the same polarity are drained off, leaving the person highly charged with the opposite polarity. Static charges of either type can cause damage; therefore, it is important to use care when handling and testing electronic components.

Diagnostic Information

The diagnostic charts and functional checks in this manual are designed to locate a faulty circuit or component through logic based on the process of elimination. **The charts are prepared with the requirement that the system functioned correctly at the time of assembly and that there are no multiple failures.**

Wiring Harness Service

Marine engine control circuits contain many special design features not found in standard land vehicle wiring. Environmental protection is used extensively to protect electrical contacts and proper splicing methods must be used when necessary.

The proper operation of low amperage input/output circuits depends upon good continuity between circuit connectors. It is important before component replacement and/or during normal troubleshooting procedures that a visual inspection of any questionable mating connector is performed. Mating surfaces should be properly formed, clean and likely to make proper contact. Some typical causes of connector problems are listed below.

1. Improperly formed contacts and/or connector housing.
2. Damaged contacts or housing due to improper engagement.
3. Corrosion, sealer or other contaminants on the contact mating surfaces.
4. Incomplete mating of the connector halves during initial assembly or during subsequent troubleshooting procedures.
5. Tendency for connectors to come apart due to vibration and/or temperature cycling.
6. Terminals not fully seated in the connector body.
7. Inadequate terminal crimps to the wire.

Wire harnesses should be replaced with proper part number harnesses. When signal wires are spliced into a harness, use the same gauge wire with high temperature insulation only.

With the low current and voltage levels found in the system, it is important that the best possible bond be made at all wire splices by soldering the splices, as shown in the following illustrations. Use care when probing a connector or replacing connector terminals. It is possible to short between opposite terminals. If this happens, certain components can be damaged. Always use jumper wires with the corresponding mating terminals between connectors for circuit checking. **NEVER** probe through connector seals, wire insulation, secondary ignition wires, boots, nipples or covers.

Microscopic damage or holes will result in eventual water intrusion, corrosion and/or component or circuit failure.

WIRE REPAIR

1. Locate damaged wire.
2. Remove insulation as required.

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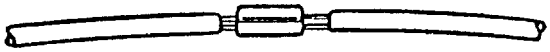
3. Splice two wires together using splice clips and rosin core solder.



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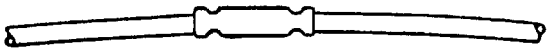
4. Cover splice with heat shrink sleeve to insulate from other wires.



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Wiring Connector Service

Most connectors in the engine compartment are protected against moisture and dirt which could create oxidation and deposits on the terminals. This protection is important because of the very low voltage and current levels found in the electronic system. The connectors have a lock which secures the male and female terminals together. A secondary lock holds the seal and terminal into the connector.

When diagnosing, open circuits are often difficult to locate by sight because oxidation or terminal misalignment are hidden by the connectors. Merely wiggling a connector on a sensor or in the wiring harness may locate the open circuit condition. This should always be considered when an open circuit or failed sensor is indicated. Intermittent problems may also be caused by oxidized or loose connections.

Before making a connector repair, be certain of the type of connector. Some connectors look similar but are serviced differently. Replacement connectors and terminals are listed in the Parts Catalog.

Ensure that the connector seals are not deformed or crushed when mating the connectors together.

Abbreviations

BARO	Barometric Pressure
BAT	Battery Positive Terminal, Battery or System Voltage
B+	Battery Positive
CKT	Circuit
CONN	Connector
CYL	Cylinder
DEG	Degrees
DIAG	Diagnostic
DIST	Distributor
DLC	Data Link Connector
DTC	Diagnostic Trouble Code
DVOM	Digital Volt Ohm Meter
ECM	Engine Control Module
ECT	Engine Coolant Temperature
EEPROM	Electronic Erasable Programmable Read Only Memory
HEI	High Energy Ignition
EMI	Electromagnetic Interference
ENG	Engine
GND	Ground
GPH	Gallons Per Hour
IAC	Idle Air Control
IAT	Intake Air Temperature
IC	Ignition Control

IGN	Ignition
INJ	Injection
kPa	Kilopascal
KS	Knock Sensor System
KV	Kilovolts
MAP	Manifold Absolute Pressure
MIL	Malfunction Indicator Lamp
mSec	Millisecond
N/C	Normally Closed
N/O	Normally Open
PROM	Programmable Read Only Memory
RAM	Random Access Memory
REF HI	Reference High
REF LO	Reference Low
ROM	Read Only Memory
SLV	Slave
SW	Switch
TACH	Tachometer
TERM	Terminal
TP	Throttle Position
V	Volts
VAC	Vacuum
WOT	Wide Open Throttle
in-hg	Inches Of Mercury

Changes In Terminology

Due to industry standardization of terminology for certain electronic engine controls some names and abbreviations have changed.

From	To
(CTS) Coolant Temperature Sensor	(ECT) Engine Coolant Temperature
(TPS) Throttle Position Sensor	(TP) Throttle Position
(MAT) Manifold Air Temperature	(IAT) Intake Air Temperature
(EST) Electronic Spark Timing	(IC) Ignition Control
(ESC) Electronic Spark Control	(KS) Knock Sensor
(ALDL) Assembly Line Data Link	(DLC) Data Link Connector

Diagnostic Trouble Codes

Code Number	Code Description
Code 12	Ignition On - Engine Not Running
Code 14	(ECT) Engine Coolant Temperature
Code 21	(TP) Throttle Position Sensor
Code 23	(IAT) Intake Air Temperature
Code 33	(MAP) Manifold Absolute Pressure
Code 42	(IC) Ignition Control
Code 43	(KS) Knock Sensor
Code 51	Calibration Memory Failure

ECM Self-Diagnostics

The ECM performs a continual self-diagnosis on certain control functions. This diagnostic capability is complemented by the diagnostic procedures contained in this manual. The ECM's language for communicating the source of a malfunction is a system of diagnostic codes. The codes are two digit numbers that can range from 12 to 51. When a malfunction is detected by the ECM, a code is set and the Malfunction Indicator Lamp is illuminated.

Diagnostic Code Tool With Malfunction Indicator Lamp

There are various manufacturers of Diagnostic Code Tools. Most Tools are equipped with a Malfunction Indicator Lamp (MIL).

- It informs the service technician that a problem has occurred and that the vessel is in need of service as soon as reasonably possible.
- It displays Codes stored by the ECM which help the technician diagnose system problems.

As a bulb and system check, the lamp will come ON with the key on and the engine not running. When the engine is started, the light will turn OFF. If the lamp remains ON, the self-diagnostic system has detected a problem. If the problem goes away, the light will go out in most cases after ten seconds, but a code will remain stored in the ECM.

When the lamp remains ON while the engine is running, or when a malfunction is suspected due to a driveability problem, "EFI Diagnostic Circuit Check" must be performed. These checks will expose malfunctions which may not be detected if other diagnostics are performed prematurely.

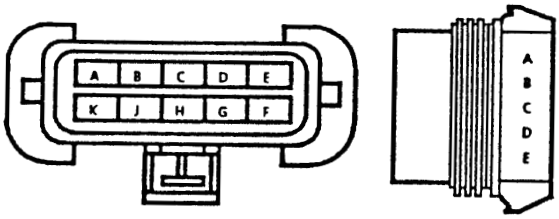
Intermittent Malfunction Indicator Lamp

In the case of an intermittent problem, the Malfunction Indicator Lamp will light for ten seconds and then will go out. However, the corresponding code will be stored in the memory of the ECM. When unexpected codes appear during the code reading process, one can assume that these codes were set by an intermittent malfunction and could be helpful in diagnosing the system.

An intermittent code may or may not reset. IF IT IS AN INTERMITTENT FAILURE, A DIAGNOSTIC CODE CHART IS NOT USED. Consult the "Diagnostic Aids" on the same page as the diagnostic code chart. "Troubleshooting" also covers the topic of "Intermittents." A physical inspection of the applicable sub-system most often will resolve the problem.

Reading Codes

The provision for communicating with the ECM is the Data Link Connector (DLC) connector. It is part of the EFI engine wiring harness, and is a 10-pin connector, which is electrically connected to the ECM. It is used in the assembly plant to receive information in checking that the engine is operating properly before it leaves the plant. The code(s) stored in the ECM's memory can be read either through a scan tool, (a diagnostic scanner that plugs into the DLC connector), or by counting the number of flashes of the Malfunction Indicator Lamp when the diagnostic code tool is installed and SERVICE mode is selected.



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DLC Connector

Once the diagnostic code tool has been connected, the ignition switch must be moved to the ON position, with the engine not running. At this point, the Malfunction Indicator Lamp should flash Code 12 three times consecutively. This would be the following flash sequence: flash, pause, flash-flash, long pause, flash, pause, flash-flash, long pause, flash, pause, flash-flash. Code 12 indicates that the ECM's diagnostic system is operating. If Code 12 is not indicated, a problem is present within the diagnostic system itself, and should be addressed by consulting the appropriate diagnostic chart in "Diagnostics."

Following the output of Code 12, the Malfunction Indicator Lamp will indicate a diagnostic code three times if a code is present, or it will simply continue to output Code 12. If more than one diagnostic code has been stored in the ECM's memory, the codes will be output from the lowest to the highest, with each code being displayed three times.

If a scan tool is used to read the codes, follow the manufacturer's instructions.

SERVICE MODE

When the diagnostic code tool is installed at the Data Link Connector (DLC) and the selector switch is set at SERVICE, the system will enter what is called the SERVICE mode. In this mode the ECM will:

1. Display a Code 12 by flashing the Malfunction Indicator Lamp (indicating the system is operating correctly).
2. Display any stored codes by flashing the Malfunction Indicator Lamp. Each code will be flashed three times, then Code 12 will be flashed again.
3. The IAC valve moves to its fully extended position, blocking the idle air passage. This is important to remember, as an attempt to run the vessel while in SERVICE mode will most likely result in an abnormally low idle speed or a stalled engine.
4. Holds ignition advance steady.

NORMAL MODE

Engines can be monitored in the normal mode. Certain parameters can be observed without changing the engine operating characteristics.

Scan Tools

The ECM can communicate a variety of information through the DLC connector. This data is transmitted at a high frequency which requires a scan tool for interpretation.

With an understanding of the data which the tool displays, and knowledge of the circuits involved, the tool can be very useful in obtaining information which would be more difficult or impossible to obtain with other equipment.

Scan tools do not make the use of diagnostic charts unnecessary, nor can they indicate exactly where a problem is in a particular circuit. Tree charts incorporate diagnosis procedures using a scan tool where possible or a Diagnostic Code Tool (non-scan) if a scan tool is unavailable.

EFI Diagnostic Circuit Check

After the visual/physical inspection, the EFI Diagnostic Circuit Check is the starting point for all diagnostic procedures. Refer to EFI Diagnostic Circuit Check.

The correct procedure to diagnose a problem is to follow two basic steps.

1. Are the on-board diagnostics working? This is determined by performing the EFI Diagnostic Circuit Check. Since this is the starting point for the diagnostic procedures, always begin here. If the on-board diagnostics are not working, the EFI Diagnostic Circuit Check will lead to a diagnostic chart in "Diagnostics" to correct the problem. If the on-board diagnostics are working correctly, go to step 2.
2. If there is a code stored: If a code is stored, go directly to the numbered code chart in "Diagnostics." This will determine if the fault is still present.

Scan Tool Use with Intermittents

The scan tool allows manipulation of wiring harnesses or components with the engine not running, while observing the scan tool readout.

The scan tool can be plugged in and observed while running the vessel under the condition when the Malfunction Indicator Lamp turns ON momentarily or when the engine driveability is momentarily poor. If the problem seems to be related to certain parameters that can be checked on the scan tool, they should be checked while running the vessel. If there does not seem to be any correlation between the problem and any specific circuit, the scan tool can be checked on each position, watching for a period of time to see if there is any change in the readings that indicates intermittent operation.

The scan tool is also an easy way to compare the operating parameters of a poorly operating engine with those of a known good one. For example, a sensor may shift in value but not set a trouble code. Comparing the senor's readings with those of the typical scan tool data readings may uncover the problem.

The scan tool has the ability to save time in diagnosis and prevent the replacement of good parts. The key to using the scan tool successfully for diagnosis lies in the technician's ability to understand the system he is trying to diagnose as well as an understanding of the scan tool operation and limitations. The technician should read the tool manufacturer's operating manual to become familiar with the tool's operation.

CLEARING CODES USING DIAGNOSTIC CODE TOOL (NON-SCAN)

1. Install diagnostic code tool.
2. Turn key ON.
3. Select service mode on code tool.
4. To clear codes, move the throttle, while in neutral, from 0% to 100% then back to 0%.
5. Exit “Service Mode” on code tool.
6. Start engine and let run for fifteen seconds.
7. Turn key OFF for 5 seconds.
8. Select “Service Mode” on code tool.
9. Turn key ON and read codes. If codes are still present, check note following and repeat from Step 1.
10. Refer to appropriate Troubleshooting and/or Diagnostic Charts

A poorly charged battery or engine cranking problem may result in an ECM “reset” and may not allow stored trouble codes to be cleared from EEPROM memory. If this condition exists, BE SURE the battery is fully charged.

NOTE: If a low battery condition does exists the audio warning buzzer will come on for 2 seconds after engine start-up.

CLEARING CODES USING SCAN TOOL (SCAN)

1. Connect scan tool.
2. Start engine.
3. Select clear codes function.
4. Clear codes.
5. Turn key OFF.
6. Turn key ON and read codes. If codes are still present, (there is a real fault in system) check following note and repeat Step 1.

NOTE: *When clearing codes without the use of a scan tool, the battery must be fully charged. The ability to clear codes is directly dependent on the battery being fully charged and able to start the engine with adequate cranking RPM.*

Non-Scan Diagnosis of Driveability Concerns (With No Codes Set)

If a driveability concern still exists after following the diagnostic circuit check and reviewing “Troubleshooting,” an out-of-range sensor may be suspected. Because of the unique design of the EFI system, fail-safes have been incorporated into the ECM to replace a sensed value with a default value in the case of a sensor malfunction or sensor wiring concern. By allowing this to occur, limited engine performance is restored until the vessel is repaired. A basic understanding of sensor operation is necessary in order to diagnose an out-of-range sensor.

If the sensor is within its working or acceptable parameters, as shown, the ECM does not detect a problem. If the sensor should happen to fall out of this “window,” a code will be stored. A known default value will replace the sensed value to restore engine performance.

If the sensor is out of range, but still within the operating window of the ECM, the problem will go undetected by the ECM and may result in trouble later.

A good example of this would be if the coolant sensor was reading incorrectly and indicating to the ECM that coolant temperature was at 20° F, but actual coolant temperature was 175° F. This would cause the ECM to deliver more fuel than was actually needed and result in an overly rich, rough running condition. This condition would not have caused a code to set as the ECM interprets this as within its range.

To identify a sensor which is out of range, unplug it while running the engine. After approximately two minutes, the diagnostic code for that sensor will set, a code, and replace the sensed value with a default value. If at that point a noticeable performance increase is observed, the non-scan code chart for that particular sensor should be followed to correct the problem.

NOTE: *Be sure to clear each code after disconnecting and reconnecting each sensor. Failure to do so may result in a misdiagnosis of the problem.*

Special Tools

Part Number	Tool Name	Description
J-34029-A(Note 1)	High Impedance Multi-meter (DVM)	Minimum 10 megohm input impedance required on all voltage ranges. As ammeter, accurately measures low value current flow. As ohmmeter, reads 0-200 ohms, 2/20/200 kΩ, 2/20 mΩ
J-23738	Vacuum Pump with Gauge - 20 In. Hg Minimum	Gauge monitors manifold engine vacuum. Hand pump used to check fuel pressure regulator
J-34142-B (Note 2)	Unpowered Test Light	Used to check circuit wiring, short to ground, or voltage.
91-99379	Timing Light	Used to check ignition timing. Must have inductive signal pickup.
91-16850A-1	Fuel Pressure Gauge	Used to check fuel system pressure.
J-34730-2A	Injector Harness Test Light	Visually indicates injector electrical impulses from the ECM.
91-823686A2	Quicksilver Scan Tool	Displays problem codes stored in the ECM. It also allows monitoring of various circuits and components in the fuel injection system.
84-822560A2	MERCRUISER Cable	
91-822608--1	MERCRUISER Cartridge	
94040M	EFI Scan Tool/Injector Tester (Rinda Technologies)	Displays problem codes stored in the ECM. It also allows monitoring of various circuits and components in the fuel injection system. Allows for test firing injectors.
94008	Diagnostic Code Tool (Rinda Technologies)	Flashes light to display problem codes
J-35616	Harness Test Adapter	Allows multi-meter connections with wiring harness.
91-805918	Fuel Shut Off Tool	Used to perform fuel system pressure tests
91-805747A1	Timing Tool Jumper Plug	Used to set Ignition timing. Plug connects to DLC
91-806901	Fuel Line Connector	Allows connection of Fuel Pressure Gauge

NOTE 1: The High Impedance Multimeter that comes with the existing Outboard EFI Tester (91-11001A1) meets the requirements listed above.

NOTE 2: Using a test light with 100 mA or less rating may show a faint glow when test actually states no light.

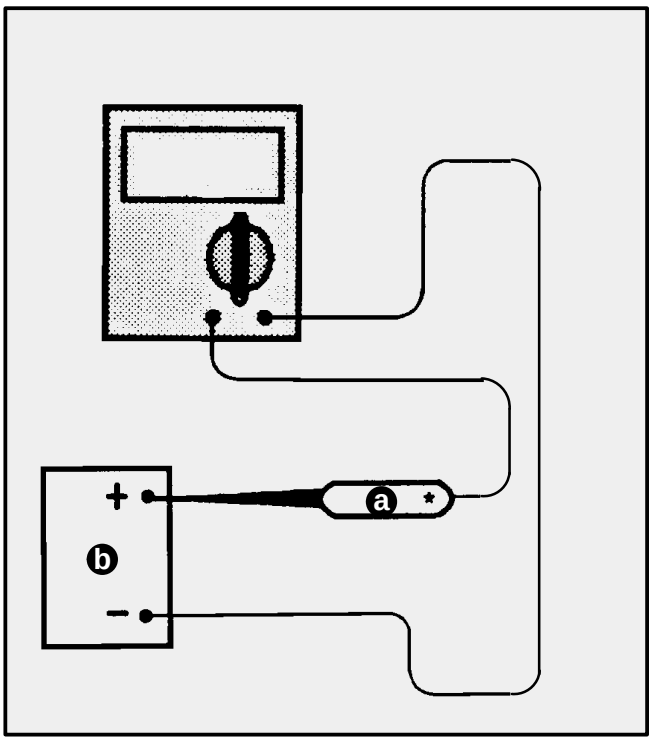
Kent-Moore Tools, Inc.
29784 Little Mack
Roseville, MI 48066
Phone: 800-345-2233

Rinda Technologies
4563 N. Elston Ave.
Chicago, IL 60630
Phone: 312-736-6633

Service Precautions

The following requirements must be observed:

1. Before removing any ECM system component, disconnect the negative battery cable.
2. Never start the engine without the battery being solidly connected.
3. Never separate the battery from the on-board electrical system while the engine is running.
4. Never separate the battery feed wire from the charging system while the engine is running.
5. When charging the battery, disconnect it from the boat's electrical system.
6. Ensure that all cable harnesses are connected solidly and that battery connections are thoroughly clean.
7. Never connect or disconnect the wiring harness at the ECM when the ignition is switched ON.
8. Before attempting any electric arc welding, disconnect the battery leads and the ECM connector(s).
9. When steam cleaning engines, do not direct the steam cleaning nozzle at ECM system components. If this happens, corrosion of the terminals or damage of components can take place.
10. Use only the test equipment specified in the diagnostic charts, since other test equipment may either give incorrect results or damage good components.
11. All voltage measurements using a voltmeter require a digital voltmeter with a rating of 10 megohms input impedance.
12. When a test light is specified, a "low-power" test light must be used. DO NOT use a high-wattage test light. While a particular brand of test light is not suggested, a simple test, as shown below, on any test light will ensure it to be safe for system circuit testing. Connect an accurate ammeter (such as the high impedance digital multimeter) in series with the test light being tested, and power the test light ammeter circuit with the vehicle battery.



a - Test Light
b - Battery

IMPORTANT: If the ammeter indicates **LESS** than 3/10 amp. current flow (.3 A or 300 mA), the test light is SAFE to use.
If the ammeter indicates **MORE** than 3/10 amp. current flow (.3 A or 300 mA), the test light is NOT SAFE to use.

NOTE: *Using a test light with 100 mA or less rating may show a faint glow when test actually states no light.*

13. When using a DVOM to perform voltage measurements, turn the ignition OFF when connecting the DVOM to the circuitry to be tested.

Electronic Control Module (ECM) and Sensors

General Description

The MerCruiser Electronic Fuel Injection system is equipped with a computer that provides the operator with state-of-the-art control of fuel and spark delivery. Computers use voltage to send and receive information.

Computers and Voltage Signals

Voltage is electrical pressure. Voltage does not flow in circuits. Instead, voltage causes current. Current does the real work in electrical circuits. It is current, the flow of electrically charged particles, that energizes solenoids, closes relays and lights lamps.

Besides causing currents in circuits, voltage can be used as a signal. Voltage signals can send information by changing levels, changing waveform (shape), or changing the speed at which the signal switches from one level to another. Computers use voltage signals to communicate with one another. The different sections inside computers also use voltage signals to communicate with each other.

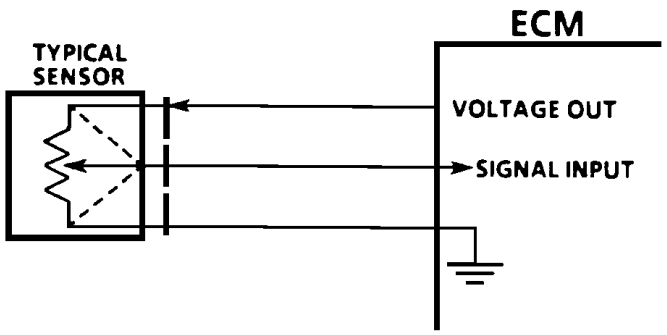
There are two kinds of voltage signals, analog and digital. Both of these are used in computer systems. It's important to understand the difference between them and the different ways they are used.

Analog Signals

An analog signal is continuously variable. This means that the signal can be any voltage within a certain range. An analog signal usually gives information about a condition that changes continuously over a certain range. For example, in a marine engine, temperature is usually provided by an analog signal. There are two general types of sensors that produce analog signals: the 3-wire and the 2-wire sensor.

THREE-WIRE SENSORS (MAP AND TP)

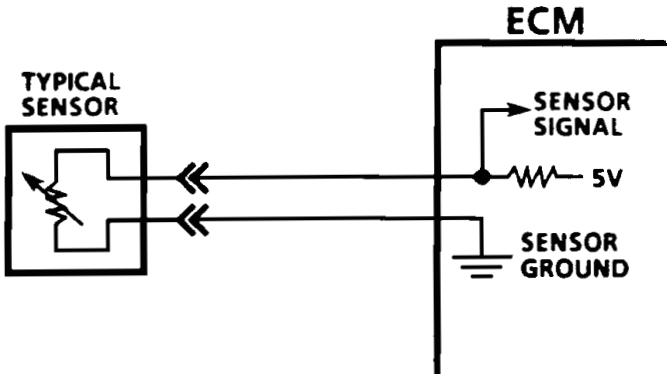
The following figure shows a schematic representation of a 3-wire sensor. All 3-wire sensors have a reference voltage, a ground and a variable "wiper." The lead coming off of the wiper will be the signal to the Engine Control Module (ECM). As this wiper position changes, the signal voltage returned to the computer also changes.



3-Wire Sensor

TWO-WIRE SENSORS (ECT AND IAT)

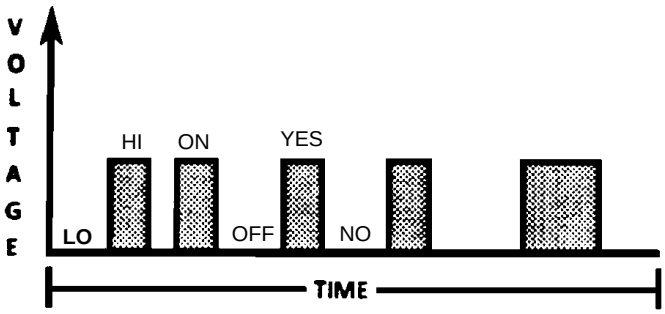
The following figure is the schematic of a 2-wire type sensor. This sensor is basically a variable resistor in series with a fixed-known resistor within the computer. By knowing the values of the input voltage and the voltage drop across the known resistor, the value of the variable resistor can be determined. The variable resistors that are commonly used are called thermistors. A thermistor's resistance varies inversely with temperature.



2-Wire Sensor

Digital Signals

Digital signals are also variable, but not continuously. They can only be represented by distinct voltages within a range. For example, 1 V, 2 V or 3 V would be allowed, but 1.27 V or 2.65 V would not. Digital signals are especially useful when the information can only refer to two conditions - “YES” and “NO,” “ON” and “OFF,” or “High” and “Low.” This would be called a digital binary signal. A digital binary signal is limited to two voltage levels. One level is a positive voltage, the other is no voltage (zero volts). As you can see in the following figure, a digital binary signal is a square wave.



Digital Binary Signal

The computer uses digital signals in a code that contains only ones and zeros. The high voltage of the digital signal represents a one (1), and no voltage represents a zero (0). Each zero and each one is called a bit of information, or just a “bit.” Eight bits together are called a “word.” A word, therefore, contains some combination of eight binary code bits: eight ones, eight zeros, five ones and three zeros, and so on.

Binary code is used inside a computer and between a computer and any electronic device that understands the code. By stringing together thousands of bits, computers can communicate and store an infinite variety of information. To a computer that understands binary, 11001011 might mean that it should reset engine RPM at a lower level. Although the computer uses 8-bit digital codes internally and when talking to another computer, each bit can have a meaning.

SWITCH TYPES

Switched inputs (also known as discretes) to the computer can cause one bit to change, resulting in information being communicated to the computer. Switched inputs can come in two types: they are “pull-up” and “pull-down” types. Both types will be discussed.

With a pull-up type switch, the ECM will sense a voltage when the switch is CLOSED. With the pull-down switch, the ECM recognizes the voltage when the switch is OPEN.

Discretes can also be used to inform a computer of FREQUENCY information.

PULSE COUNTERS

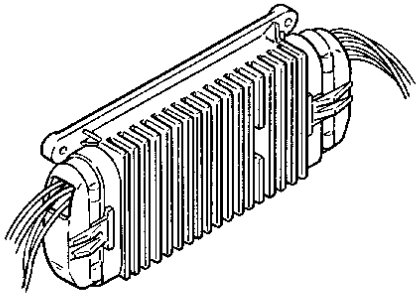
For the computer to determine frequency information from a switched input, the computer must measure the time between voltage pulses. As a number of pulses are recorded in a set amount of time, the computer can calculate the frequency. The meaning of the frequency number can have any number of meanings to the computer.

An example of a pulse counter type of input is the distributor reference pulse input. The computer can count a train of pulses, a given number of pulses per engine revolution, and determine the RPM of the engine.

Engine Control Module (ECM)

The Engine Control Module (ECM) is the control center of the fuel injection system. It constantly monitors information from various sensors, and controls the systems that affect engine performance.

The ECM also performs a diagnostic function check of the system. It can recognize operational problems and store a code or codes which identify the problem areas to aid the technician in making repairs.



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Electronic Control Module (ECM)

ECM FUNCTION

The ECM supplies 5 or 12 volts to power various sensors or switches. This is done through resistances in the ECM which are so high in value that a test light will not light when connected to the circuit. In some cases, even an ordinary shop voltmeter will not give an accurate reading because its resistance is too low. Therefore, the use of a **10 megohm input impedance digital voltmeter** is required to assure accurate voltage readings.

MEMORY

There are three types of memory storage within the ECM: ROM, RAM and EEPROM.

ROM

Read Only Memory (ROM) is a permanent memory that is physically soldered to the circuit boards within the ECM. The ROM contains the overall control programs. Once the ROM is programmed, it cannot be changed. The ROM memory is non-erasable, and does not need power to be retained.

RAM

Random Access Memory (RAM) is the microprocessor “scratch pad.” The processor can write into, or read from, this memory as needed. This memory is erasable and needs a constant supply of voltage to be retained.

EEPROM

Electronic Erasable Programmable Read Only Memory (EEPROM) is the portion of the ECM that contains the different engine calibration information that is specific to each marine application.

Speed Density System

The Electronic Fuel Injection system is a speed and air density system. The system is based on “speed/density” fuel management.

Three specific data sensors provide the ECM with the basic information for the fuel management portion of its operation. That is, three specific signals to the ECM establish the engine speed and air density factors.

SPEED

The engine speed signal comes from the distributor’s High Energy Ignition (HEI) module to the ECM on the distributor reference high circuit. The ECM uses this information to determine the “speed” or RPM factor for fuel and ignition management.

DENSITY

Two sensors contribute to the density factor, the Intake Air Temperature (IAT) [Multi-Port models only] and the Manifold Absolute Pressure (MAP) sensors.

The IAT sensor is a 2-wire sensor that measures the temperature of the air entering the intake manifold. The IAT sensor is a thermistor that changes its resistance depending on the air temperature. When the temperature is low, the resistance is high, and when the temperature is high, the resistance is low.

The Manifold Absolute Pressure (MAP) sensor is a 3-wire sensor that monitors the changes in intake manifold pressure which results from changes in engine loads. These pressure changes are supplied to the ECM in the form of electrical signals.

As intake manifold pressure increases (vacuum decreases), the air density in the intake manifold also increases, and additional fuel is required.

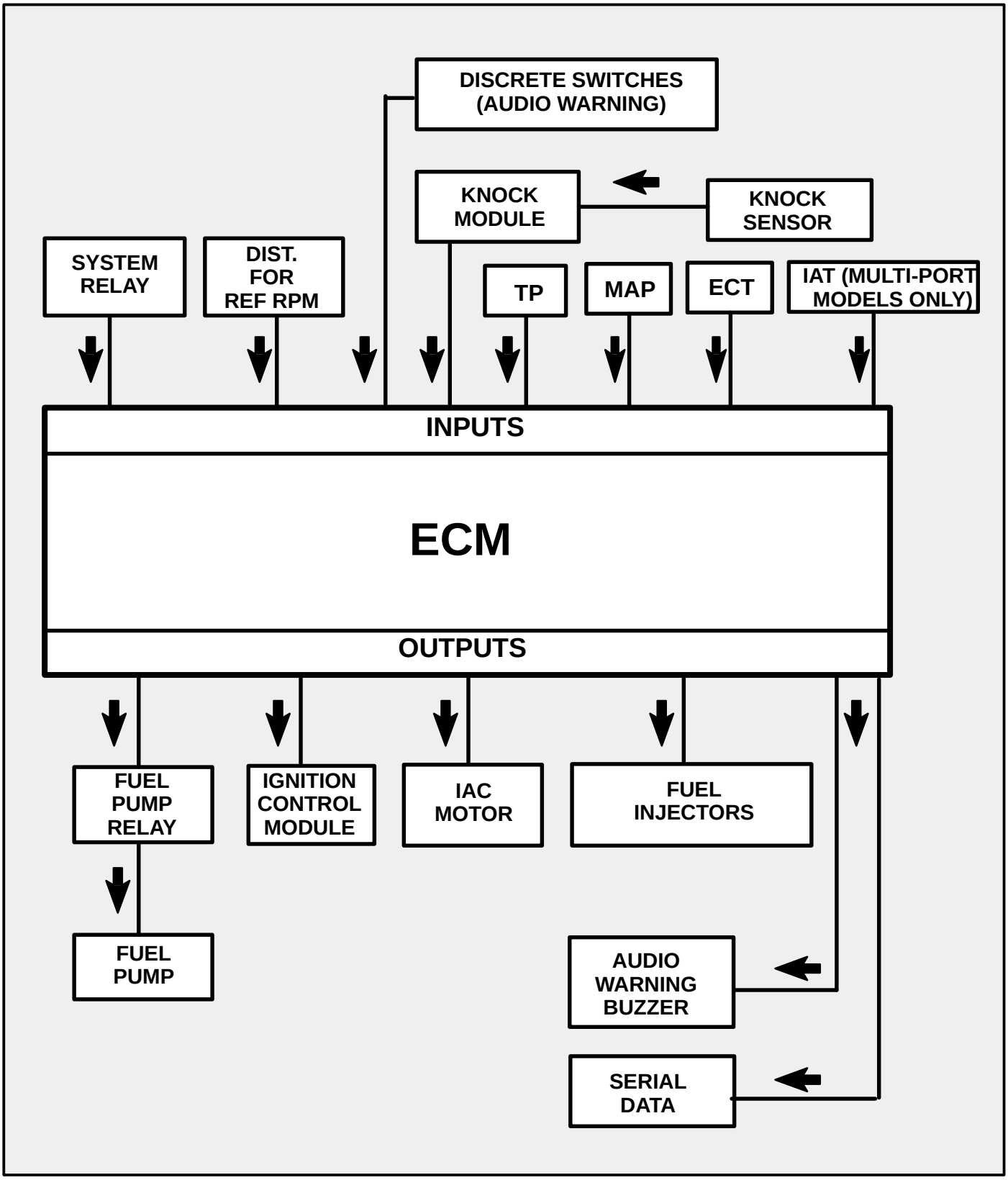
The MAP sensor sends this pressure information to the ECM, and the ECM increases the amount of fuel injected by increasing the injector pulse width. As manifold pressure decreases (vacuum increases), the amount of fuel is decreased.

These three inputs MAP, IAT and RPM are the major determinants of the air/fuel mixture, delivered by the fuel injection system.

The remaining sensors and switches provide electrical inputs to the ECM which are used for modification of the air/fuel mixture, as well as for other ECM control functions, such as Idle Air Control (IAC).

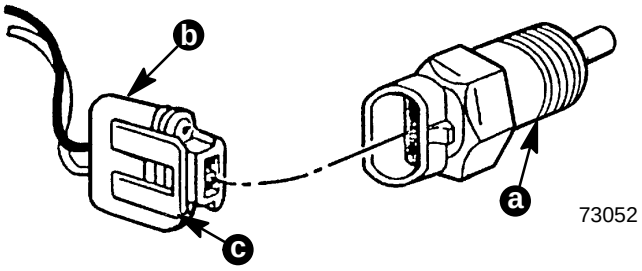
ECM Input and Sensor Descriptions

The following lists the sensors, switches, and other inputs used by the ECM to control its various systems. Although we will not cover them all in great detail, there will be a brief description of each.



ENGINE COOLANT TEMPERATURE (ECT) SENSOR

The Engine Coolant Temperature (ECT) Sensor is a thermistor (a resistor which changes value based on temperature) immersed in the engine coolant stream. Low coolant temperature produces a high resistance, while high temperature causes low resistance.



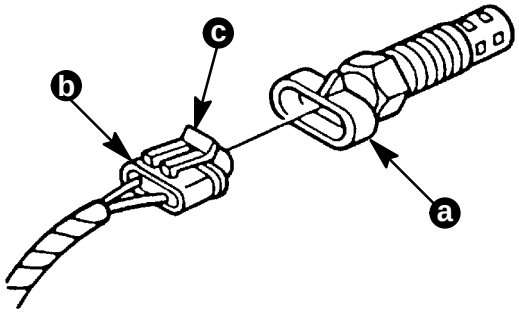
a - Engine Coolant Temperature (ECT) Sensor
b - Harness Connector
c - Locking Tab

The ECM supplies a 5 volt signal to the ECT through a resistor in the ECM and measures the voltage. The voltage will be high when the engine is cold, and low when the engine is hot. By measuring the voltage, the ECM knows the engine coolant temperature. Engine coolant temperature affects most systems the ECM controls.

A failure in the ECT circuit should set Code 14. Remember, this code indicates a failure in the coolant temperature sensor circuit, so proper use of the chart will lead to either repairing a wiring problem or replacing the sensor.

INTAKE AIR TEMPERATURE (IAT) SENSOR [MULTI-PORT INJECTION MODELS ONLY]

The Intake Air Temperature (IAT) sensor is a thermistor (a resistor which changes value based on temperature) mounted on the underside of the plenum. Low temperature produces a high resistance, while high temperature causes a low resistance.



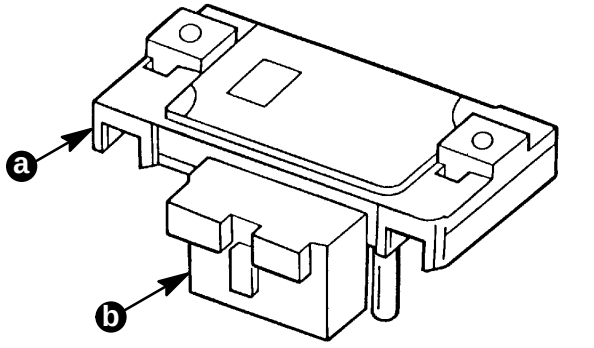
a - Intake Air Temperature (IAT) Sensor
b - Harness Connector
c - Locking Tab

The ECM supplies a 5 volt signal to the sensor through a resistor in the ECM and measures the voltage. The voltage will be high when the intake air is cold, and low when the intake manifold air is hot.

A failure in the IAT sensor circuit should set a Code 23.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

The Manifold Absolute Pressure (MAP) sensor is a pressure transducer that measures the changes in the intake manifold pressure. The pressure changes as a result of engine load and speed change, and the MAP sensor converts this to a voltage output.



a - Manifold Absolute Pressure (MAP) Sensor
b - Electrical Connector

A closed throttle on engine coast-down would produce a relatively low MAP output voltage, while a wide open throttle would produce a high MAP output voltage. This high output voltage is produced because the pressure inside the manifold is the same as outside the manifold, so 100% of outside air pressure is measured. When manifold pressure is high, vacuum is low. The MAP sensor is also used to measure barometric pressure under certain conditions, which allows the ECM to automatically adjust for different altitudes.

The ECM sends a 5 volt reference signal to the MAP sensor. As the manifold pressure changes, the electrical resistance of the MAP sensor also changes. By monitoring the sensor output voltage, the ECM knows the manifold pressure. A higher pressure, low vacuum (high voltage) requires more fuel, while a lower pressure, higher vacuum (low voltage) requires less fuel. The ECM uses the MAP sensor to control fuel delivery and ignition timing.

A failure in the MAP sensor circuit should set a Code 33.

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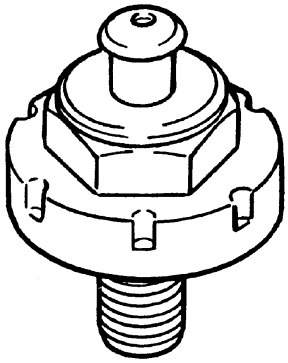
KNOCK SENSOR

The knock sensor is mounted on the lower right side of the engine block.



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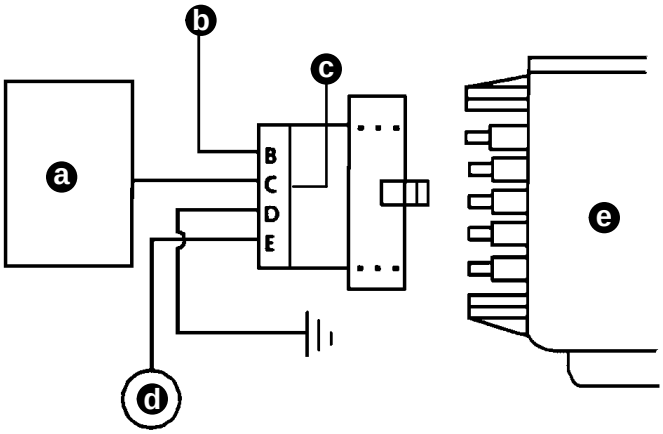
When abnormal engine vibrations (spark knock) are present, the sensor produces a voltage signal which is sent to the KS Module and then to the ECM. The ECM uses this signal to aid in calculating ignition timing.

KNOCK SENSOR (KS) MODULE

The KS module contains solid state circuitry which monitors the knock sensor's AC voltage signal and then supplies an 8-10 volt signal, if no spark knock is present, to the ECM. If spark knock is present, the KS module will remove the 8-10 volt signal to the ECM.



Knock Sensor System

a - Electronic Control Module (ECM)
b - 12 Volts Battery Positive
c - 8-12 Volts
d - Knock Sensor
e - Knock Sensor Module

It is extremely important that the correct KS sensor and module be used for the engine application. Using an incorrect KS module will result in unrecognized spark knock and engine damage. The KS module terminal B is powered by 12 volts from the ignition switch thru system relay. If the 12 volt power source is not present, the KS module cannot send an 8-10 volt signal to the ECM and a false constant spark retard will result. A code 43 will be set.

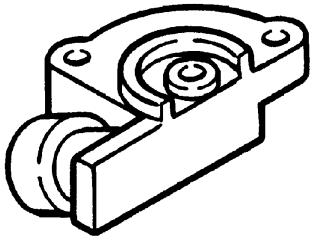
Terminal E of the KS module is the signal line from the knock sensor. If this circuit opens or shorts to ground, the KS module will never remove the 8-10 volt signal from terminal C to the ECM and no spark retard will occur. The ground circuit for the KS module is connected to terminal D. If the ground circuit opens, the KS module will not be able to remove the 8-10 volt signal to the ECM and spark knock cannot be controlled.

On certain models **(serial number OF417516 and below)**, the ECM will do a self test when the following conditions are reached:

- Engine temperature above 150° F (66° C).
- Engine RPM above 4000 RPM.
- 5.024 Hg in. (80 kPa) manifold pressure

THROTTLE POSITION (TP) SENSOR

The Throttle Position (TP) Sensor is a potentiometer connected to the throttle shaft on the throttle body. The TP has one end connected to 5 volts from the ECM and the other to ECM ground. A third wire is connected to the ECM to measure the voltage from the TP. As the throttle valve angle is changed, the voltage output of the TP also changes. At a closed throttle position, the voltage output of the TP is low (approximately .5 volt). As the throttle valve opens, the output increases so that at wide-open-throttle (W.O.T.), the output voltage should be near 4.5 volts. By monitoring the output voltage from the TP, the ECM can determine fuel delivery based on throttle valve angle (driver demand). A broken or loose TP can cause intermittent bursts of fuel from the injector and an unstable idle, because the ECM thinks the throttle is moving.



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If the TP circuit is open, the ECM will set a Code 21. If the TP circuit is shorted, and a trouble Code 21 will be set. A problem in any of the TP circuits will set a Code 21. Once a trouble code is set, the ECM will use a default value for TP.

DISTRIBUTOR REFERENCE (DIST REF)

The distributor reference (engine speed signal) is supplied to the ECM by way of the “Dist Ref Hi” line from the High Energy Ignition (HEI). This pulse counter type input creates the timing signal for the pulsing of the fuel injectors, as well as the Ignition Control (IC) functions. This signal is used for a number of control and testing functions within the ECM.

DISCRETE SWITCH INPUTS - POWER REDUCTION MODE (1996 AND OLDER MODELS)

Several discrete switch inputs are utilized by the system to identify abnormal conditions that may affect engine operation. Pull-down switches are used in conjunction with the ECM to detect critical conditions to engine operation.

If a switch changes state from its normal at rest position, that is normally open to closed, the ECM senses a change in voltage and responds by entering power reduction mode.

This engine protection feature allows the operator full engine power up to 2800 RPM, but disables half of the fuel injectors above 2800 RPM until the engine RPM drops to 1200 RPMS.

This feature allows the operator a comfortable maneuvering speed while removing the possibility of high RPM engine operation until the problem is corrected.

Switches which are used with the Fuel Injection system to detect critical engine operation parameters are:

Switch	Normal State
Oil Pressure	N/O
I/O Fluid Level on Stern Drive	N/O
Transmission Temperature on MIE Models	N/O
Engine Coolant Temperature	N/O

IMPORTANT: Models equipped with multiple engines must use dual engine data link kit and common ground between engine blocks. Otherwise there will be no serial data communication between engines and the power reduction mode will not control both engines.

- Triple (three) engine applications should connect the outboard engines.
- Quad (four) engine applications Should link the outer two outboard engines with one link and the two inboard engines with another link.

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Spark Management

High Energy Ignition with Ignition Control (IC)

The Electronic Fuel Injection is controlled by an Engine Control Module (ECM). This module is the nerve/decision center of the system. It uses all the information it gathers to manage ignition spark, delivering increased fuel economy and maximum engine performance.

The system uses inputs from sensors to make decisions on the amount of spark advance or retard allowed.

The system has been designed to control ignition advance and retard electronically by the ECM.

In order for the ECM to properly calculate spark advance, it must always know at what speed the engine is running. The engine speed signal is accomplished by a circuit within the distributor module which converts the pickup coil voltage to a square wave reference signal that can be used by the ECM. This square wave engine speed reference signal is known as REF HI. The ECM must also have something to compare the REF HI value against. Therefore, an additional line is provided between the ECM and the distributor module that is known as REF LO. These two lines, between the ECM and the distributor, provide a precise indication of engine speed.

The two other lines between the ECM and distributor which control the Ignition Control (IC) operation are known as the bypass and IC circuits.

Modes Of Operation

There are two modes of ignition system operation:

DISTRIBUTOR MODULE MODE

The ignition system operates independent of the ECM. The distributor module module in the distributor maintains a base ignition timing and is able to advance timing to a total of 27 degrees. This mode is in control when a Code 42 is detected while engine is running and will have a noticeable affect on engine operation.

ECM CONTROL MODE

The ECM control mode controls the ignition timing. The ECM calculates the desired ignition timing based on information it gets from its input sensors.

Distributor Module Mode

The following describes IC operation during cranking and when the engine starts running. To help understand how IC circuits operate, a relay with a double set of contact points is shown in the IC module (refer to the figures “Ignition Control Mode” and “ECM Control Mode”). Solid state circuitry is used in the module, but showing the relay makes it easier to visualize how the IC module functions.

During cranking, the relay is in the de-energized position (see figure “Distributor Module Mode”). This connects the pickup coil to the base of the transistor via the signal converter. When the pickup coil applies a positive voltage to the transistor, the transistor turns ON. When voltage is removed, the transistor turns OFF. When the transistor turns ON, current flows through the primary winding of the ignition coil. When it turns OFF, the primary current stops and a spark is developed at the spark plug. A small amount of advance is built into the IC module via a timing circuit, in case the engine remains in the ignition module timing mode.

With the relay de-energized, a set of contacts (shown closed) would ground the IC line signal.

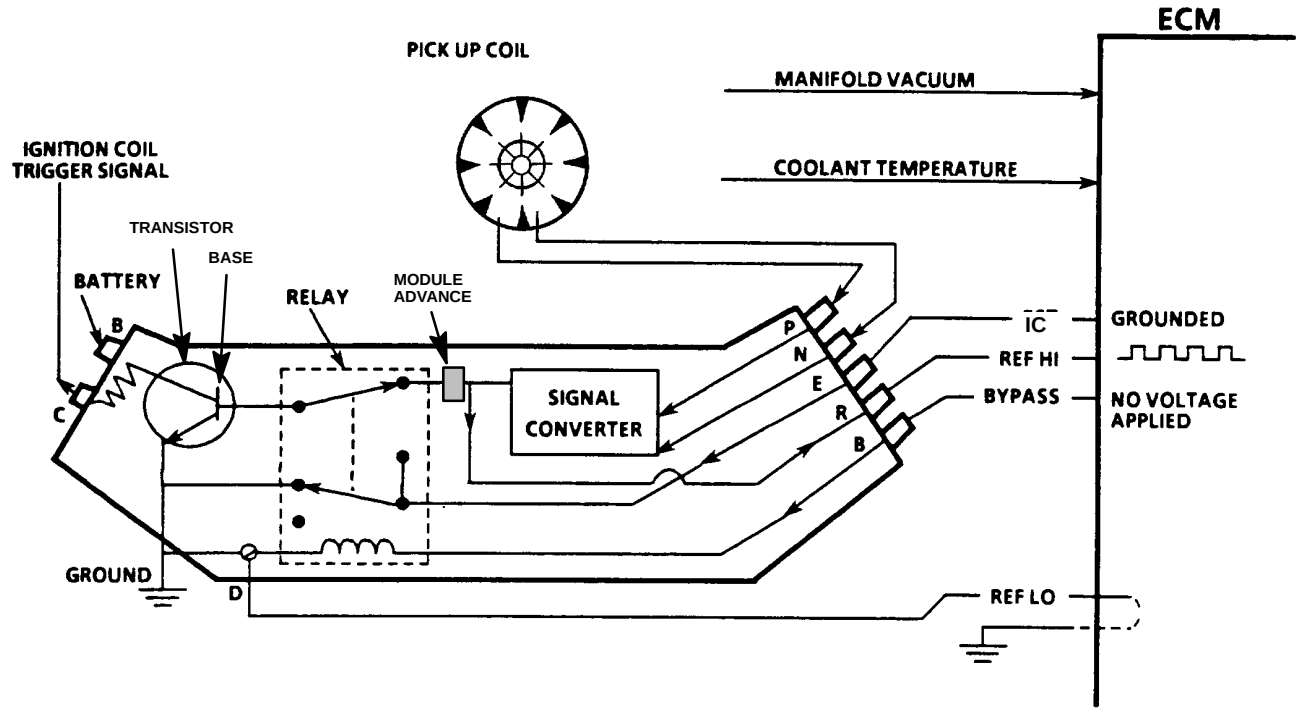
ECM Control Mode

When the engine RPM reaches a predetermined value (for this example, 300 RPM), the ECM considers the engine running and applies five volts on the bypass line to the IC module. This energizes the relay and causes the contacts from the pickup coil as well as the grounding contacts for the IC line to open (see figure “ECM Control Mode”). This connects the IC line to the base of the transistor, and bypasses the ignition module timing control.

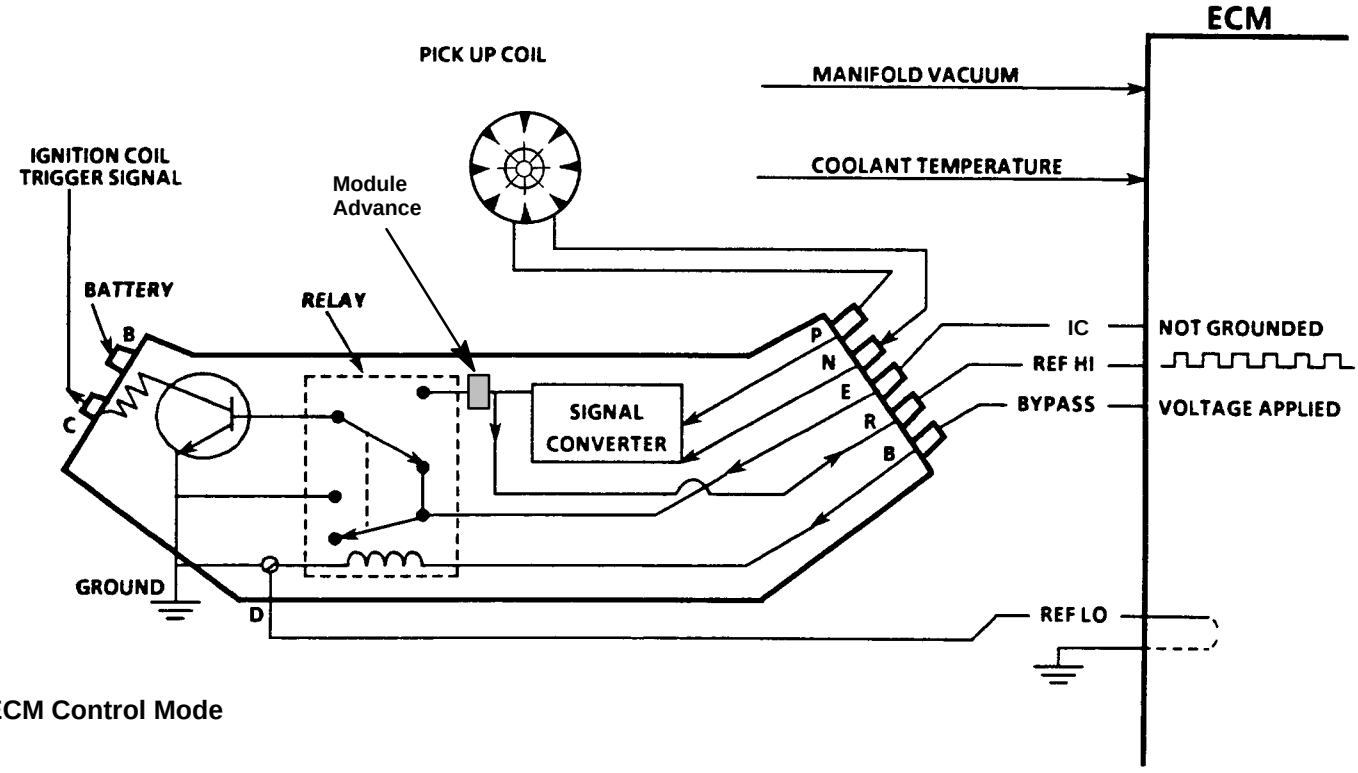
The IC system is now controlled by the IC signal from the ECM and the time at which the spark occurs can be determined by a variable time circuit in the ECM.

Base Ignition Timing

In order to check or change base timing on a HEI system the ECM has to be entered into the service mode by using a scan tool or code tool. The IC module will go to base timing. The ECM will stabilize timing to allow timing adjustment. The ECM incorporates a spark control override, which allows timing to be lowered if spark knock (detonation) is encountered during normal operation. At this time, the timing can be adjusted by turning the distributor.



Distributor Module Mode



ECM Control Mode

Results of Incorrect Operation

Open IC Line from the ECM to the Distributor Module - While the engine is cranking, the ECM expects to see the IC signal pulled to virtually zero because it is grounded in the distributor module. Since the IC line is open, it cannot be grounded by the module and the IC signal will be able to rise and fall, or do what is called toggling. The ECM recognizes the toggling as an abnormal condition, and will not apply bypass voltage to the distributor module when the engine reaches run RPM.

Since bypass voltage is not applied to the relay, it remains open and the engine continues to run on the pickup coil triggering in the ignition module timing mode.

If this condition occurs while the engine is running, the engine will stop, but it will restart and run in the ignition module timing mode with reduced power.

Grounded IC Line - During cranking, the IC voltage is at virtually zero so the ECM does not recognize a problem. When engine RPM reaches the value for the run condition, the ECM applies bypass voltage to the distributor module. Bypass voltage on the module switches the distributor power transistor to the IC line. Because the IC line is grounded, it will have no voltage applied so it cannot operate the power transistor to enter the IC mode.

If the IC line becomes grounded while the engine is being operated, the engine will stop and will be difficult to restart.

An open or ground in the IC or bypass will cause the engine to run on the distributor module timing. This will cause reduced performance, poor fuel economy and erratic idle.

Grounded or Open Bypass Line - While the engine is cranking, the IC line will be grounded and the ECM will not notice anything abnormal. When run RPM is reached, the ECM applies bypass voltage to the bypass line but because of the ground or open, it will not be able to energize the relay. Therefore, the relay will stay de-energized and the IC line will remain grounded.

When the ECM sees the IC line not toggling, it will not enter the IC mode. Since the relay is de-energized, the engine will continue to run in the ignition module timing mode.

If this condition occurs while the engine is running, the engine will simply operate in the ignition module timing mode.

Open or Grounded REF HI Line - This line provides the ECM with engine speed information. If this line is open or grounded, the ECM will not know that the engine is cranking or running and will not run.

Open or Grounded REF LO Line - This wire is grounded in the ignition module and provides a reference ground from the ignition module to the ECM. The ECM compares reference ground with reference high voltage. If this circuit is open, or grounded at any other location than through the module, it may cause poor performance.

Fuel Metering System

General Description

The function of the fuel metering system is to deliver the correct amount of fuel to the engine under all operating conditions.
Multi-Port Injection, fuel is delivered to the engine by individual fuel injectors mounted in the intake manifold near each cylinder.
Throttle Body Injection, fuel is delivered from two injectors mounted atop the intake manifold.

Modes of Operation

The ECM looks at voltages from several sensors to determine how much fuel to give the engine. The fuel is delivered under one of several conditions, called modes. All the modes are controlled by the ECM and are described below.

STARTING MODE

When the ignition switch is turned to the crank position, the ECM turns ON the fuel pump relay and the fuel pump builds up pressure. The ECM then checks the Engine Coolant Temperature (ECT) sensor and Throttle Position (TP) sensor and determines the proper air/fuel ratio for starting. The ECM controls the amount of fuel delivered in the starting mode by changing how long the injectors are turned ON and OFF. This is done by pulsing the injectors for very short times.

CLEAR FLOOD MODE

If the engine floods, it can be cleared by opening the throttle half way (50%). (Open throttle handle until resistance from secondary throttle [Multi-Port only] is felt.) The ECM discontinues fuel injector pulsation as long as the throttle is between 50 to 75 % and the engine RPM is below 300. If the throttle position becomes more than 75% or less than 50%, the ECM returns to the starting mode.

RUN MODE

When the engine is started and RPM is above 300, the system operates in the run mode. The ECM will calculate the desired air/fuel ratio based on these ECM inputs: RPM, Manifold Absolute Pressure (MAP) sensor, Intake Air Temperature (IAT) sensor and Engine Coolant Temperature (ECT) sensor . Higher engine load (from MAP) and colder engine temperature (from ECT) requires more fuel, or a richer air/fuel ratio.

ACCELERATION MODE

The ECM looks at rapid changes in Throttle Position (TP) and provides extra fuel by increasing the injector pulse width.

FUEL CUTOFF MODE

No fuel is delivered by the injectors when the ignition is OFF, to prevent dieseling. Also, fuel pulses are not delivered if the ECM receives no distributor reference pulses, which means the engine is not running. The fuel cutoff mode is also enabled at high engine RPM, as an overspeed protection for the engine. When cutoff is in effect due to high RPM, injection pulses will resume after engine RPM drops slightly.

POWER REDUCTION MODE (1996 AND OLDER MODELS)

The ECM will go into power reduction mode when the following conditions are met:

1. Low oil pressure
2. Engine overheat
3. Low I/O fluid level (MCM)
4. High transmission temperature (MIE)

The ECM recognizes change of state in a discrete switch input that identifies an abnormal condition that may affect proper drive train operation.

As an engine protection feature, power reduction mode allows normal fuel injection up to 2800 RPM. Above 2800 RPM, fuel delivery is limited to half of the injectors until RPM lowers to 1200 RPM when normal fuel injection resumes.

This feature maintains maneuverability of the vessel while removing the possibility of high RPM operation until the problem is corrected.

DECELERATION MODE

The IAC is similar to a carburetor dashpot. It provides additional air when the throttle is rapidly moved to the idle position to prevent the engine from dying.

Fuel Metering System Components

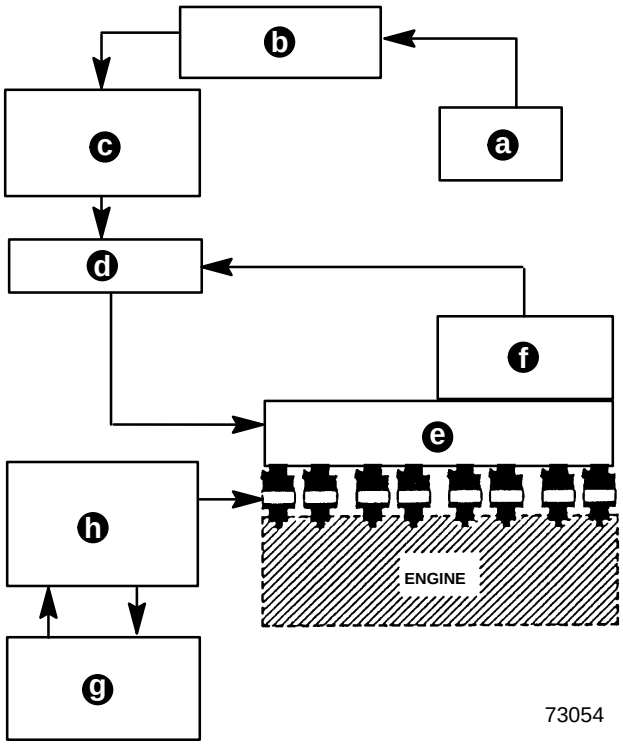
Multi-Port Vapor Separator Tank (VST)

The fuel metering system is made up of the following components:

- Fuel supply components (fuel tank, mechanical pump, lines, etc.).
- Vapor Separator Tank (VST).
- Fuel pump electrical circuit.
- Fuel rail assembly, including:

  Fuel injectors.

  Pressure regulator assembly.



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Fuel Metering System

a - Mechanical Fuel Pump
b - Vapor Separator Tank (VST)
c - Electronic Control Module
d - Network Of Engine Sensors
e - Water Separating Fuel Filter
f - Fuel Pressure Regulator
g - Fuel Rail Assembly
h - Fuel Tank

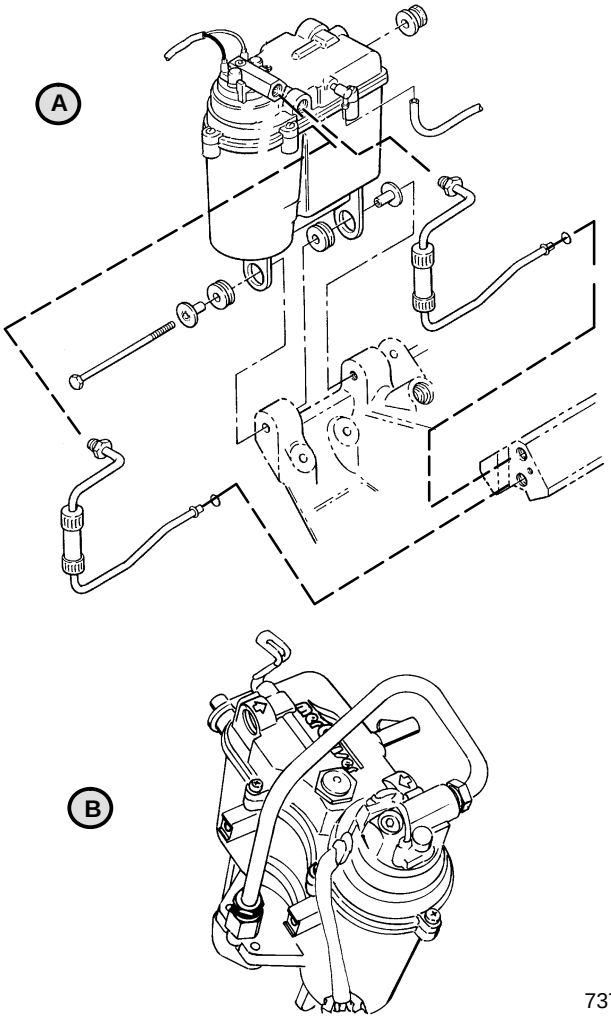
FUEL SUPPLY COMPONENTS

Fuel is drawn from the boat's fuel supply tank, through a water separating fuel filter, by a mechanical fuel pump mounted on and driven by a seawater pump, and is delivered to the Vapor Separator Tank (VST).

VAPOR SEPARATOR TANK (VST)

An electric fuel pump located in the VST pumps fuel to the fuel rail assembly. The pump is designed to provide fuel at a pressure greater than that required by the injectors. The pressure regulator, part of the fuel rail assembly, regulates fuel pressure to the fuel injectors. Unused fuel is returned to the VST.

NOTE: *MCM 454 Magnum Multi-Port with serial number (0F130438) and MCM 502 Magnum Multi-Port with serial number (0F128962) and higher will be equipped with fuel lines as shown in figure A. Fuel line shown in figure B is a replacement line per Service Bulletin 93-26. If VST does not have style A or B refer to to this service bulletin.*



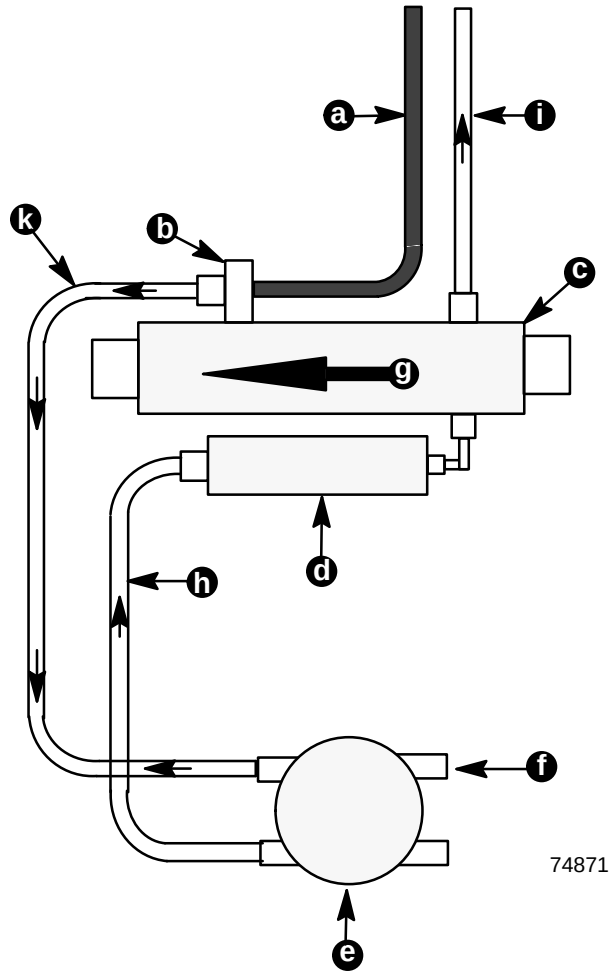
73797

Cool Fuel System

The Cool Fuel System consists of an electrical fuel pump, water separating fuel filter and port mounted fuel cooler.

Fuel is drawn from the boat fuel tank through a water separating fuel filter by an electric fuel pump then through fuel cooler. Fuel is fed to fuel injectors in the throttle body (or fuel rail on multi-port injection system). Excess fuel is routed back to water separating fuel filter from the pressure regulator mounted on the fuel cooler.

FUEL FLOW DIAGRAM



Throttle Body Injection System (Typical)

a - Vacuum Line To Flame Arrestor (Throttle Body Injection) Or Fuel Rail (Multi-Port Injection)
b - Fuel Pressure Regulator
c - Fuel Cooler
d - Electric Fuel Pump
e - Water Separating Fuel Filter
f - Fuel From Tank
g - Direction Of Water Flow
h - Fuel Line To Fuel Pump
i - Fuel Line To Throttle Body (Throttle Body Injection) Or Fuel Rail (Multi-Port Injection)
j - Excess Fuel Return To Water Separating Fuel Filter

Throttle Body Injection Components

FUEL PUMP ELECTRICAL COMPONENTS

When the ignition switch is turned to the RUN position, the ECM will turn ON the fuel pump relay for two seconds.

When the ignition switch is turned to the crank position, the ECM turns the fuel pump relay ON causing the fuel pump to start.

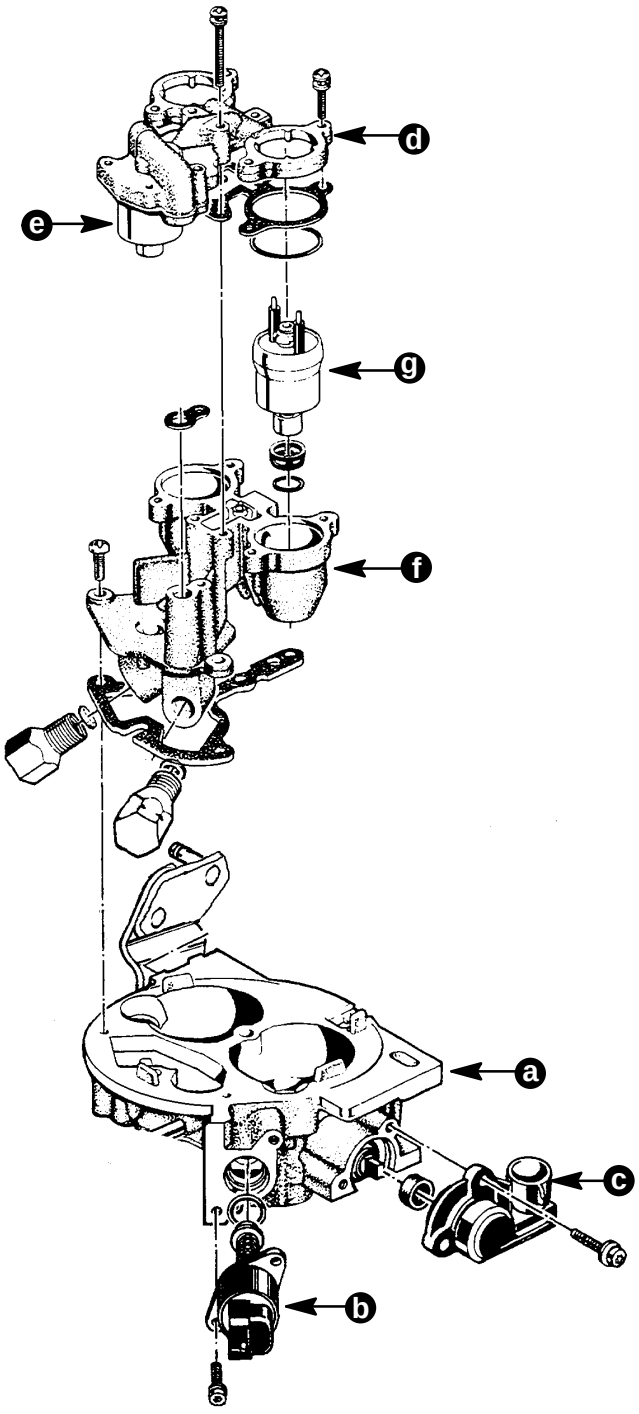
If the ECM does not receive ignition reference pulses (engine cranking or running), it shuts Off the fuel pump relay, causing the fuel pump to stop.

THROTTLE BODY UNIT

The throttle body unit consists of three assemblies.

- Fuel meter cover and fuel damper
- Fuel meter body and fuel injectors
- Throttle Body
  - -Two Throttle Valves To Control Air Flow Into The Engine
  - -Idle Air Control (IAC) Valve
  - -Throttle Position (Tp) Sensor

THROTTLE BODY UNIT EXPLODED VIEW



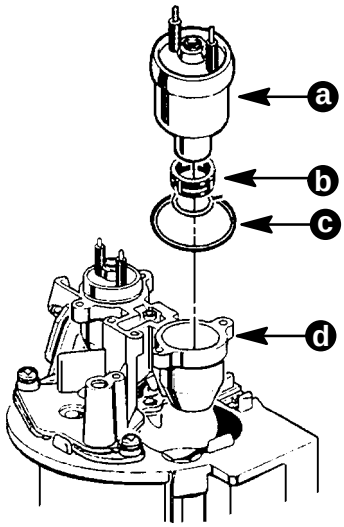
73766

a - Throttle Body
b - Idle Air Control (IAC) Valve
c - Throttle Position (TP) Sensor
d - Fuel Meter Cover
e - Fuel Damper
f - Fuel Meter Body
g - Fuel Injector (2)

FUEL INJECTORS

The injector assembly is a solenoid operated device, controlled by the ECM, that meters pressurized fuel to the intake manifold. The ECM energizes the injector solenoid, which opens a ball valve, allowing fuel to flow past the ball valve, and through a recessed flow director plate.

The director plate has six machined holes that control the fuel flow, generating a conical spray pattern of finely atomized fuel at the injector tip. Fuel is directed at the throttle, causing it to become further atomized before entering the intake manifold.

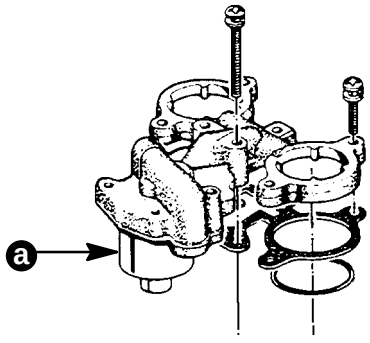


73773

a - Fuel Injector
b - Fuel Filter
c - Seal Ring
d - Fuel Meter Body

FUEL DAMPER

The fuel damper acts as an equalization device to reduce the pressure spikes caused by the fuel injectors.



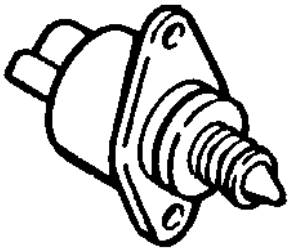
73766

Throttle Body Injection Shown

a - Fuel Damper

IDLE AIR CONTROL (IAC) VALVE

The purpose of the IAC valve assembly is to control engine idle speed, while preventing stalls due to changes in engine load. The IAC valve, mounted in the throttle body, controls bypass air around the throttle valves.



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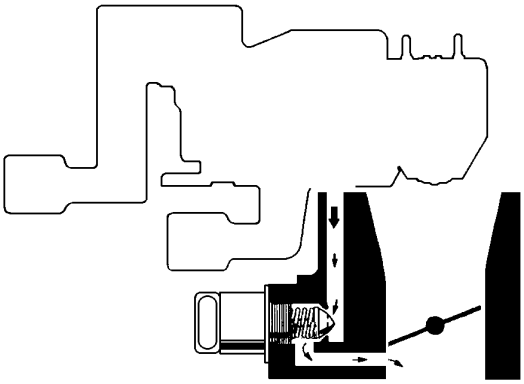


IAC Valve Air Flow Diagram

By moving a conical valve known as a pintle, IN, toward the seat (to decrease air flow), or OUT, away from the seat (to increase air flow), a controlled amount of air moves around the throttle valve. If RPM is too low, more air is bypassed around the throttle valve to increase it. If RPM is too high, less air is bypassed around the throttle valve to decrease it.

The ECM moves the IAC valve in small steps, called counts. These can be measured by scan tool test equipment, which plugs into the DLC.

During idle, the proper position of the IAC valve is based on engine RPM. If the RPM drops below specification and the throttle valve is closed, the ECM senses a near stall condition and calculates a new valve position to prevent stalling.

- Engine idle speed is a function of total air flow into the engine based on IAC valve pintle position + throttle valve stop screws and PCV.
- "Controlled" idle speed is programmed into the ECM, which determines the correct IAC valve pintle position to maintain the desired idle speed for all engine operating conditions and loads.
- The minimum idle air rate is set at the factory with stop screws. This setting allows enough air flow by the throttle valves to cause the IAC valve pintle to be positioned a calibrated number of steps (counts) from the seat during "controlled" idle operation.
- If the IAC valve is disconnected and reconnected with the engine running, the idle speed may be wrong. In this case, the IAC valve can be reset by doing the following: turn off engine, wait ten seconds, and restart engine.

Multi-Port Injection Components

FUEL PUMP ELECTRICAL CIRCUIT

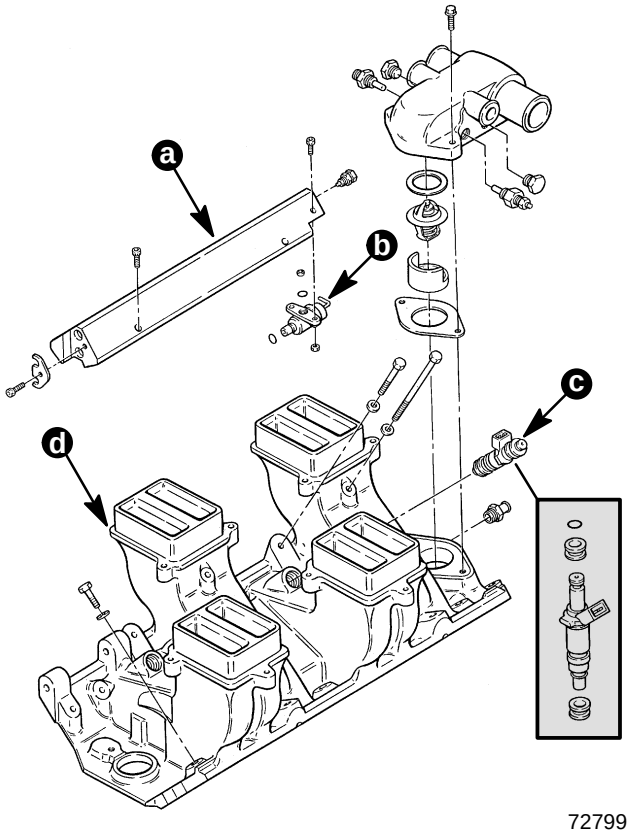
When the ignition switch is turned to the RUN position, the ECM will turn ON the fuel pump relay for two (2) seconds.

When the ignition switch is turned to the crank position, the ECM turns the fuel pump relay ON causing the fuel pump to start.

If the ECM does not receive ignition reference pulses (engine cranking or running), it shuts OFF the fuel pump relay, causing the fuel pump to stop.

FUEL RAIL/INTAKE MANIFOLD ASSEMBLY

The fuel rail performs several functions. It positions the injectors in the intake manifold, distributes fuel evenly to the injectors, and integrates the fuel pressure regulator into the fuel metering system.



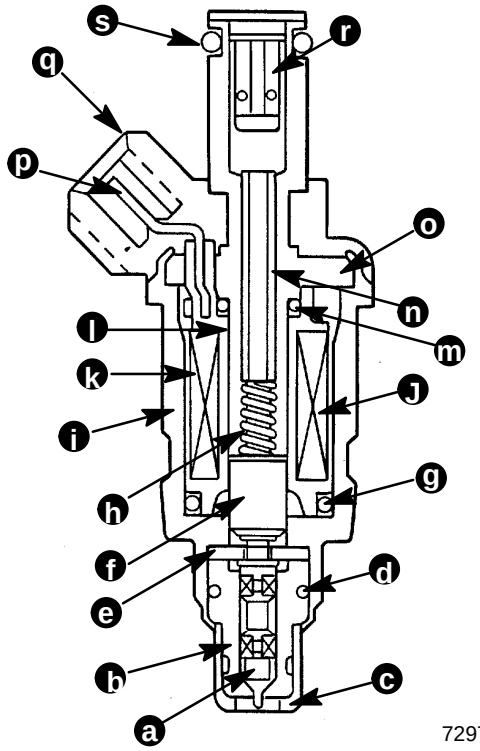
72799

a - Fuel Rail
b - Pressure Regulator
c - Fuel Injector
d - Intake Manifold

FUEL INJECTORS

The EFI injector assembly is a solenoid-operated device, controlled by the ECM, that meters pressurized fuel to a single engine cylinder. The ECM grounds the injector solenoid, which opens a pintle valve, allowing fuel to flow past the pintle valve. The injector tip has holes that control the fuel flow, generating a conical spray pattern of finely atomized fuel at the injector tip. Fuel is directed at the intake valve, causing it to become further atomized and vaporized before entering the combustion chamber.

An injector that is stuck partly open will cause loss of pressure after engine shutdown. This can result in long cranking times. Dieseling can also occur, because some fuel might be delivered to the engine after the ignition is turned OFF.

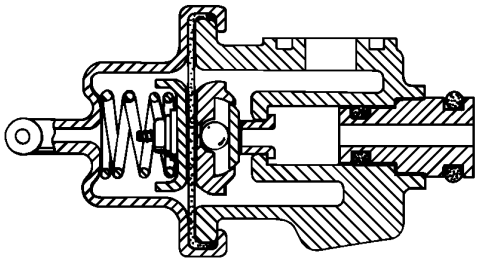


72970

a - Needle Valve
b - Nozzle
c - Cap
d - O-Ring
e - Valve Stopper
f - Core
g - O-Ring
h - Spring
i - Housing
j - Solenoid Coil
k - Tape
l - Bobbin
m - O-Ring
n - Inner Collar
o - Sleeve
p - Terminal
q - Connector
r - Filter
s - O-Ring

PRESSURE REGULATOR ASSEMBLY

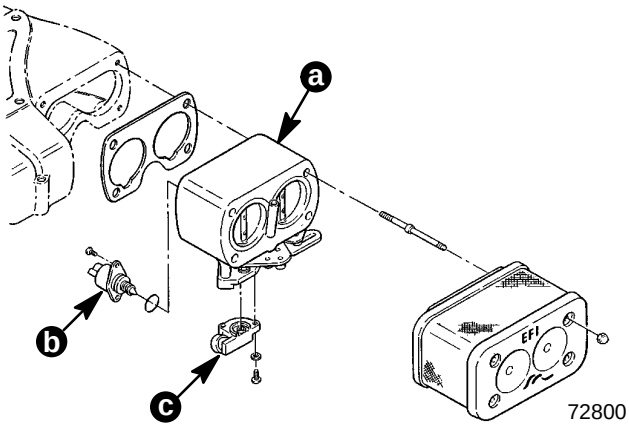
The pressure regulator is a diaphragm-operated relief valve with fuel pump pressure on one side, and regulator spring pressure and intake manifold vacuum on the other. The regulator's function is to maintain a constant pressure differential across the injectors at all times. The pressure regulator compensates for engine load by increasing fuel pressure as engine vacuum drops.


71716

Throttle Body Assembly

The throttle body assembly is attached to the plenum, and is used to control air flow into the engine, thereby controlling engine output. The throttle valves within the throttle body are opened by the operator through the accelerator controls. During engine idle, the throttle valves are almost closed, and air flow control is handled by the Idle Air Control (IAC) valve, described below.

The throttle body also provides the location for mounting the Throttle Position (TP) sensor for sensing throttle valve position.



72800

a - Throttle Body
b - Idle Air Control (IAC) Valve
c - Throttle Position Sensor

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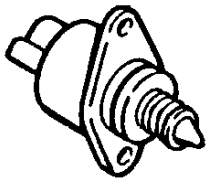
IDLE AIR CONTROL (IAC) VALVE

The purpose of the IAC valve assembly is to control engine idle speed, while preventing stalls due to changes in engine load. The IAC valve, mounted in the throttle body, controls bypass air around the throttle valves.



72800

Idle Air Control (IAC) Valve Assembly

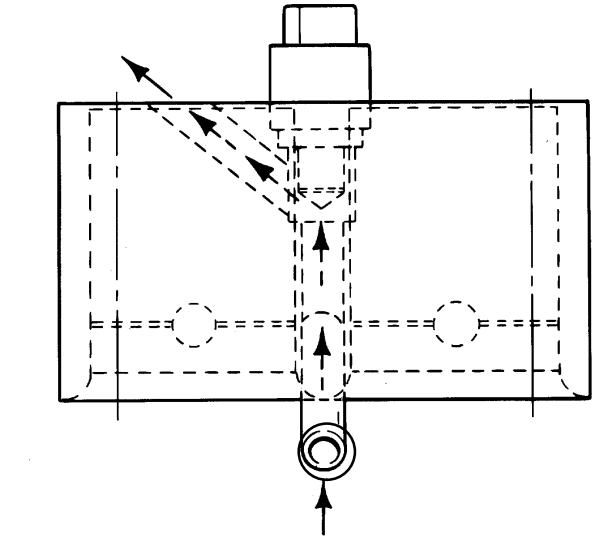
By moving a conical valve known as a pintle, IN, toward the seat (to decrease air flow), or OUT, away from the seat (to increase air flow), a controlled amount of air moves around the throttle valve. If RPM is too low, more air is bypassed around the throttle valve to increase it. If RPM is too high, less air is bypassed around the throttle valve to decrease it.

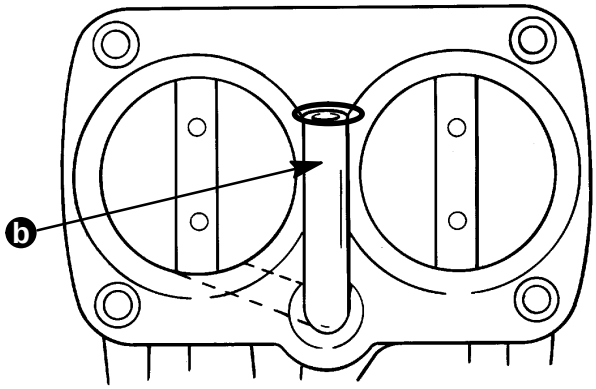
The ECM moves the IAC valve in small steps, called counts. These can be measured by scan tool test equipment, which plugs into the DLC connector.

During idle, the proper position of the IAC valve is engine load, and engine RPM. If the RPM drops below specification and the throttle valve is closed, the ECM senses a near stall condition and calculates a new valve position to prevent stalling.

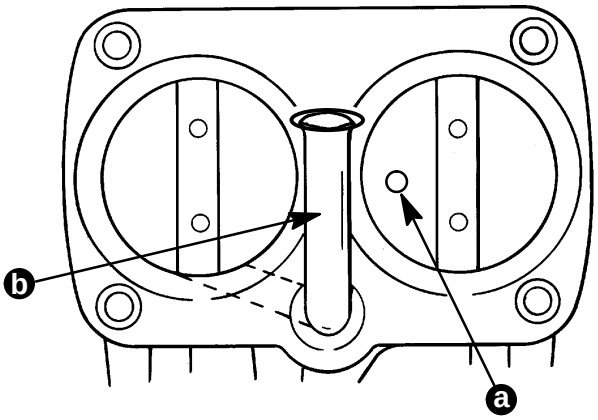
- Engine idle speed is a function of total air flow into the engine based on IAC valve pintle position.
- “Controlled” idle speed is programmed into the ECM, which determines the correct IAC valve pintle position to maintain the desired idle speed for all engine operating conditions and loads.
- The minimum idle air rate is set at the factory with stop screws. This setting allows enough air flow by the throttle valves to cause the IAC valve pintle to be positioned a calibrated number of steps (counts) from the seat during “controlled” idle operation.
- If the IAC valve is disconnected and reconnected with the engine running, the idle speed may be wrong. In this case, the IAC valve can be reset by doing the following: Turn off engine, wait ten seconds, and restart engine.

IAC Valve Air Flow Diagram





7.4L / 454 Throttle Body



454 / 502 Throttle Body

a - Air Hole
b - Air Tube (Models With VST)

72986

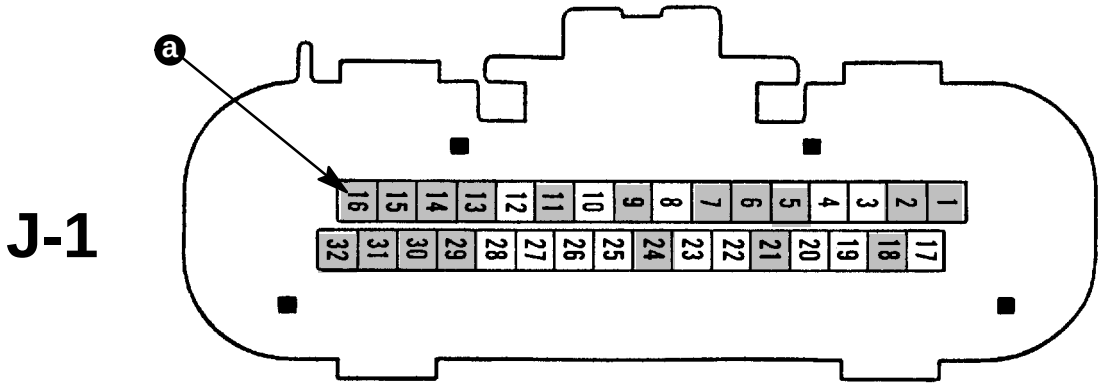
NOTE: *Not all 454 / 502 Magnums have the air hole located in the secondary throttle plate.*

ECM Connector and Symptom Charts

The following chart will aid in diagnosis of symptoms. These voltages were derived from a known good engine. The voltages shown were done with the electrical system intact and operational. These are voltage requirements to operate the different circuits.

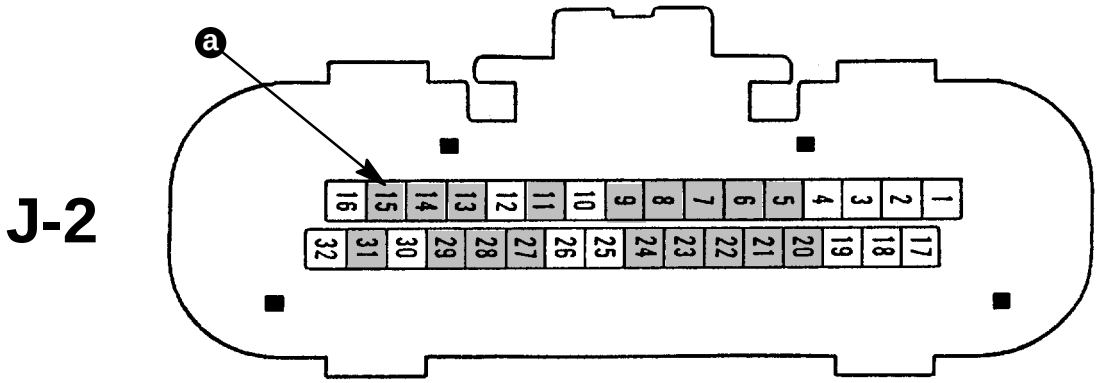
⚠CAUTION

Do not attempt to obtain these voltages by probing wires and connectors. Serious damage could result in loss of engine operation or wiring damage. Voltages can vary with battery conditions.



J-1

J-1 Front Pin 32 Pin Input Connector



J-2

J-2 Rear 32 Pin Output Connector
a - Shaded Area Denotes Pin Connector Location Used On Terminal

NOTE: *The Intake Air Temperature (IAT) Sensor [J1-24], Port Fuel Jumper J2-7 and J2-22] is not used on the 7.4L / 7.4LX Throttle Body Injection system*

IMPORTANT: The following conditions must be meet before testing.

1. Engine at operating temperature.
2. Ignition on or engine running.
3. Scan tool not connected.

THESE NOTES APPLY TO FOLLOWING ECM CONNECTOR AND SYMPTOM CHARTS.
The “B+” Symbol indicates a system voltage (battery).

NOTE 1: Battery voltage for first two seconds, then 0 volts.

NOTE 2: Varies with temperature.

NOTE 3: Varies with manifold vacuum.

NOTE 4: Varies with throttle movement.

NOTE 5: Less than .5 volt (500 mV).

NOTE 6: Dual or multiple engines must share a common ground (–) for proper serial data communications.

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ECM Connector and EFI Symptoms Chart (J-1 Circuits)

Pin	Pin Function	Circuit (CKT) Number (#)	Wire Color	Normal Voltage		Diagnostic Trouble Codes DTC(s)	Possible Symptoms
				Ignition ON	Engine Running		
J1-1	Knock Sensor Signal	485	BLK	9.5V	9.5V	43	Poor Fuel Economy, Poor Performance Detonation
J1-2	ECT Signal	410	YEL	1.95V (NOTE 2)	1.95V (NOTE 2)	14	Poor Performance, Exhaust Odor, Rough Idle RPM Reduction
J1-3	Not Used	–	–	–	–	–	–
J1-4	Not Used	–	–	–	–	–	–
J1-5	Master/ Slave	916	YEL	B+	B+	None	Lack Of Data From Other Engine (Dual Engine Only)
J1-6	Discrete Switch	931	BRN	–	–	None	Power Reduction Mode
J1-7	Diagnostic Test	451	WHT/ BLK	B+	B+	None	Incorrect Idle, Poor Performance
J1-8	Not Used	–	–	–	–	–	–
J1-9	Map Signal	432	LT GRN	4.9V	1.46V (NOTE 3)	33	Poor Performance, Surge, Poor Fuel Economy, Exhaust Odor
J1-10	TP Signal	417	DK BLU	.62V (NOTE 4)	.62V (NOTE 4)	21	Poor Performance And Acceleration, Incorrect Idle
J1-11	Ignition Fused	439	PNK/ BLK	B+	B+	None	No Start
J1-12	Not Used	–	–	–	–	–	–
J1-13	TP and IAT Ground	813	BLK	0 (NOTE 5)	0 (NOTE 5)	21,23	High Idle, Rough Idle, Poor Performance Exhaust Odor
J1-14	ECM Ground	450	BLK/ WHT	0 (NOTE 5)	0 (NOTE 5)	None	No Start
J1-15	TP 5V Reference	416	GRY	5V	5V	21	Lack Of Power, Idle High
J1-16	Battery	440	ORN	B+	B+	None	No Start

See Page 5C-29 For NOTES

ECM Connector and EFI Symptoms Chart (J-1 Circuits)

Pin	Pin Function	Circuit (CKT) Number (#)	Wire Color	Normal Voltage		Diagnostic Trouble Codes DTC(s)	Possible Symptoms
				Ignition ON	Engine Running		
J1-17	Not Used	–	–	–	–	–	–
J1-18	Serial Data	461	ORN/ BLK	5V	5V	None	No Serial Data (NOTE 6)
J1-19	Not Used	–	–	–	–	–	–
J1-20	Not Used	–	–	–	–	–	–
J1-21	Lanyard Stop Switch	942	PNK	0	0	NONE	No Start
J1-22	Not Used	–	–	–	–	–	–
J1-23	Not Used	–	–	–	–	–	–
J1-24	IAT Sensor	472	TAN	5V	(NOTE 2)	23	Poor Fuel Economy, Exhaust Odor
J1-25	Not Used	–	–	–	–	–	–
J1-26	Not Used	–	–	–	–	–	–
J1-27	Not Used	–	–	–	–	–	–
J1-28	Not Used	–	–	–	–	–	–
J1-29	MAP Ground	814	BLK	0 (NOTE 5)	0 (NOTE 5)	33	Lack Of Performance,Exhaust Odor, Stall
J1-30	ECM Ground	450	BLK/ WHT	0 (NOTE 5)	0 (NOTE 5)	None	No Start
J1-31	MAP 5V Reference	416	GRY	5V	5V	33	Lack Of Power, Surge, Rough Idle, Exhaust Odor
J1-32	Battery	440	ORN	B+	B+	None	No Start

NOTE: *The Intake Air Temperature (IAT) Sensor [J1-24] is not used on the 7.4L / 7.4LX Throttle Body Injection system. J1-21 is not used on 1997 and newer models.*

See page 5C-29 for NOTES

ECM Connector and EFI Symptoms Chart (J-2 Circuits)

Pin	Pin Function	Circuit (CKT) Number (#)	Wire Color	Normal Voltage		Diagnostic Trouble Codes DTC(s)	Possible Symptoms
				Ignition ON	Engine Running		
J2-1	Not Used	–	–	–	–	–	–
J2-2	Not Used	–	–	–	–	–	–
J2-3	Not Used	–	–	–	–	–	–
J2-4	Not Used	–	–	–	–	–	–
J2-5	Injector Driver	468	LT GRN	B+	B+	None	Rough Idle, Lack Of Power, Stall
J2-6	Ignition Control Ref. Low	463	BLK/ RED	0 (NOTE 5)	0 (NOTE 5)	None	Poor Performance
J2-7	Port Fuel Jumper	901	WHT	–	–	None	–
J2-8	Ignition Control Ref. High	430	PUR/ WHT	5V	1.6V	None	No Restart
J2-9	Fuel Pump Relay Driver	465	DK GRN/ WHT	0 (NOTE 1&5)	B+	None	No Start
J2-10	Not Used	–	–	–	–	–	–
J2-11	Coolant Over temp.	112	DK GRN	0	0	NONE	Power Reduction Mode or Improper Audio Warning
J2-12	Not Used	–	–	–	–	–	–
J2-13	IAC “A” Low	442	BLU/ BLK	Not Usable	Not Usable	None	Rough Unstable or Incorrect Idle
J2-14	IAC “B” Low	443	GRN/ WHT	Not Usable	Not Usable	None	Rough Unstable or Incorrect Idle
J2-15	Injector Ground	450	BLK/ WHT	0 (NOTE 5)	0 (NOTE 5)	None	Rough Running, Lack Of Power, Poor Performance
J2-16	Not Used	–	–	–	–	–	–

NOTE: *J2-7 is not used on the 7.4L / 7.4LX Throttle Body Injection system.*

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ECM Connector and EFI Symptoms Chart (J-2 Circuits)

Pin	Pin Function	Circuit (CKT) Number (#)	Wire Color	Normal Voltage		Diagnostic Trouble Codes DTC(s)	Possible Symptoms
				Ignition ON	Engine Running		
J2-17	Not Used	–	–	–	–	–	–
J2-18	Not Used	–	–	–	–	–	–
J2-19	Not Used	–	–	–	–	–	–
J2-20	Fuel Injector Ground	450	BLK/ WHT	0 (NOTE 5)	0 (NOTE 5)	None	Rough Running, Poor Idle, Lack Of Performance
J2-21	Injector Driver	467	DK BLU	B+	B+	None	Rough Idle, Lack Of Power, Stalling
J2-22	Port Fuel Jumper	901	WHT	–	–	–	–
J2-23	Ignition Control Signal	423	WHT	0 (NOTE 5)	1.2V	42	Stall, Will Restart In Bypass Mode, Lack Of Power
J2-24	Ignition Control Bypass	424	TAN/ BLK	0 (NOTE 5)	4.5V	42	Lack Of Power, Fixed Timing
J2-25	Not Used	–	–	–	–	–	–
J2-26	Not Used	–	–	–	–	–	–
J2-27	Discrete Switch Signal	31	TAN	–	–	–	Audio Warning System Activated
J2-28	IAC “A” High	441	BLU/ WHT	Not Usable	Not Usable	None	Rough Unstable or Incorrect Idle
J2-29	IAC “B” Low	444	GRN/ BLK	Not Usable	Not Usable	None	Rough Unstable or Incorrect Idle
J2-30	Not Used	–	–	–	–	–	–
J2-31	MIL Lamp	419	BRN/ WHT	0 (NOTE 5)	0 (NOTE 5)	None	Lamp Inoperative
J2-32	Not Used	–	–	–	–	–	–

NOTE: *J2-22 is not used on the 7.4L / 7.4LX Throttle Body Injection system*

See page 5C-29 for NOTES

Multi Port Injector Balance Test

(Refer to the following figure for test set-up.)

The injector balance tester is a tool used to turn the injector ON for a precise amount of time, thus spraying a measured amount of fuel into the manifold. This causes a drop in fuel rail pressure that we can record and compare between each injector. All injectors should have the same amount of pressure drop. Any injector with a pressure drop that is 1.5 PSI (or more) greater or less than the average drop of the other injectors should be considered faulty and replaced. Injector testers are available for various manufacturers. For 7.4L / 454 and 502 engines: the tester must be capable of selecting an injector pulse width in the range of 200-400 milliseconds (m sec). The recommended starting point for these engines is approximately 300 m sec. In any case a pulse width that drops the fuel rail pressure to half the normal operating pressure, should be used.

STEP 1

Engine cool down period (ten minutes) is necessary to avoid irregular readings due to “hot soak” fuel boiling. Relieve fuel pressure in the fuel rail as outlined in “Fuel Pressure Relief Procedure” in “Repair Procedures.” Remove plenum as outlined in “Repair Procedures.” With ignition OFF, connect fuel pressure gauge to fuel pressure tap.

Disconnect harness connectors at all injectors, and connect injector tester to one injector. Use adaptor harness furnished with injector tester to energize injectors. Follow manufacturer’s instructions for use of adaptor harness. Ignition must be OFF at least ten seconds to complete ECM shutdown cycle. Fuel pump should run about two seconds after ignition is turned ON.

At this point, insert clear tubing attached to vent valve into a suitable container and bleed air from gauge and hose to ensure accurate gauge operation. Repeat this step until all air is bled from gauge.

STEP 2

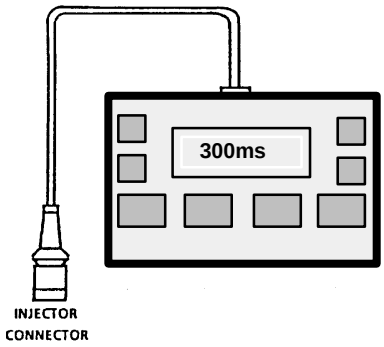
Turn ignition OFF for ten seconds and then ON again several times to get fuel pressure to its maximum. Record this initial pressure reading. Energize tester one time and note pressure drop at its lowest point. (Disregard any slight pressure increase after drop hits low point.) By subtracting this second pressure reading from the initial pressure, we have the actual amount of injector pressure drop.

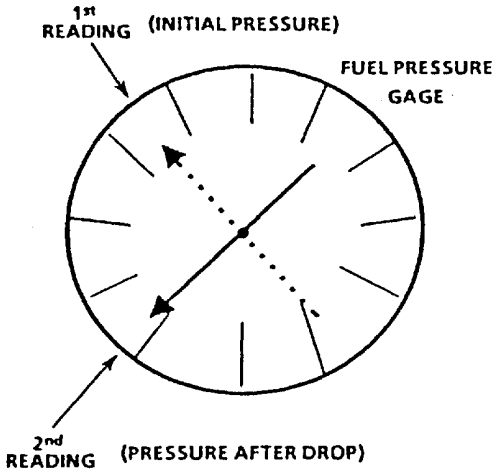
STEP 3

Repeat Step 2 on each injector and compare the amount of drop. Usually, good injectors will have virtually the same drop. Retest any injector that has a pressure difference of 1.5 PSI (10 kPa), either more or less than the average of the other injectors on the engine. Replace any injector that also fails the retest. If the pressure drop of all injectors is within 1.5 PSI (10 kPa) of this average, the injectors appear to be flowing properly. Reconnect them and review “Troubleshooting.”

NOTE: *The entire test should not be repeated more than once without running the engine to prevent flooding. (This includes any retest on faulty injectors.)*

Fuel Injector Balance Test Set-up (Multi-Port Injection)

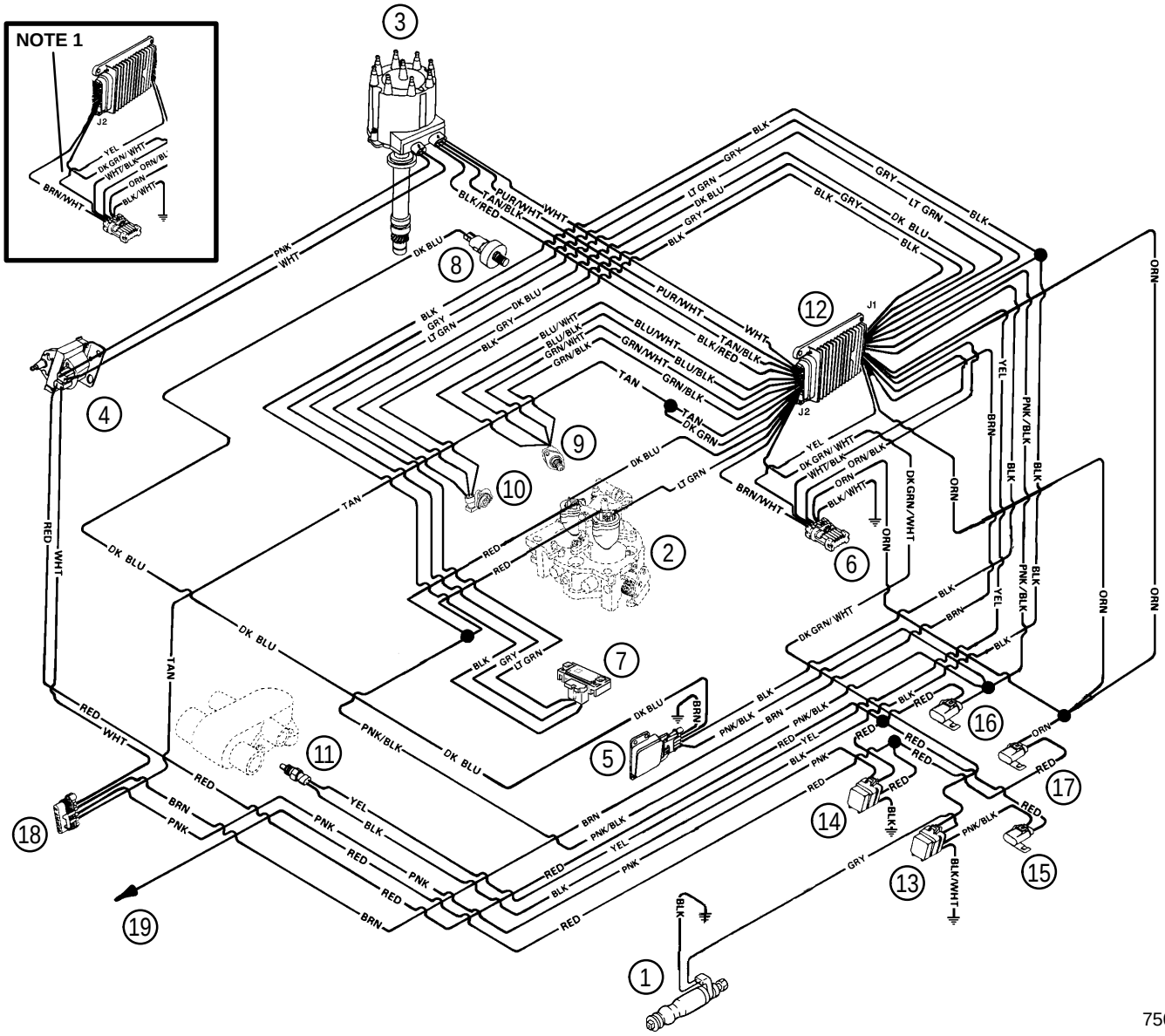




EXAMPLE								
Cylinder	1	2	3	4	5	6	7	8
1st. Reading	38 PSI (262 kPa)	38 PSI (262 kPa)	38 PSI (262 kPa)	38 PSI (262 kPa)	38 PSI (262 kPa)	38 PSI (262 kPa)	38 PSI (262 kPa)	38 PSI (262 kPa)
2nd Reading	19 PSI (131 kPa)	17 PSI (117 kPa)	21 PSI (145 kPa)	19 PSI (131 kPa)	19 PSI (131 kPa)	19 PSI (131 kPa)	19 PSI (131 kPa)	19 PSI (131 kPa)
Amount of Drop	19 PSI (131 kPa)	21 PSI (145 kPa)	17 PSI (117 kPa)	19 PSI (131 kPa)	19 PSI (131 kPa)	19 PSI (131 kPa)	19 PSI (131 kPa)	19 PSI (131 kPa)
	OK	Rich (Too Much Fuel Drop)	Lean (Too Little Fuel Drop)	OK	OK	OK	OK	OK

Wiring Harness Diagrams

MCM 7.4LX / MIE 7.4L Throttle Body Injection Bluewater Inboard



Note: All BLACK wires with a ground symbol are interconnected within the fuel injection system harness.

NOTE 1: As a mid year (1996-1/2) model change, the Throttle Body Injection models have the lanyard stop connector removed from the wiring harness. The dual engine capability is relocated by routing the YEL wire to the Data Link Connector (DLC).

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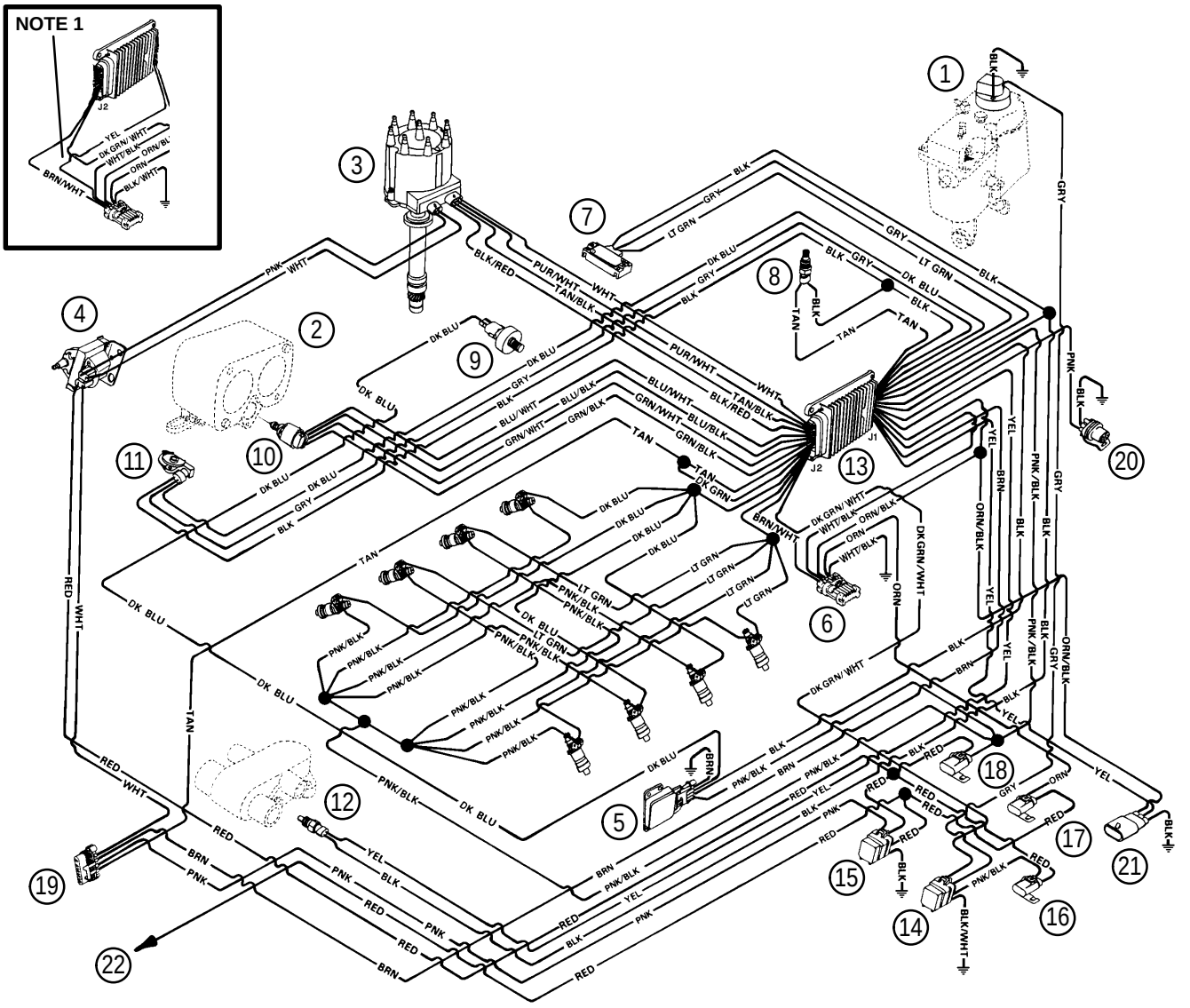
1 -Fuel Pump
2 -Throttle Body
3 -Distributor
4 -Coil
5 -Electronic Spark Control (KS) Module
6 -Data Link Connector (DLC)
7 -Manifold Absolute Pressure (MAP) Sensor
8 -Knock Sensor
9 -Idle Air Control (IAC)
10-Throttle Position (TP) Sensor
11-Engine Coolant Temperature (ECT) Sensor
12-Electronic Control Module (ECM)
13-Fuel Pump Relay
14-Ignition/System Relay
15-Fuse (15 Amp) Fuel Pump
16-Fuse (15 Amp) ECM/DLC/Battery
17-Fuse (10 Amp) ECM/Injector/Ignition/Knock Module
18-Harness Connector To Starting/Charging Harness
19-Positive (+) Power Wire To Engine Circuit Breaker

MCM 7.4LX Multi-Port Injection / 454 / 502 Magnum Multi-Port Injection / MIE 454 Tournament Ski Multi-Port Injection / 502 Magnum Multi-Port Injection



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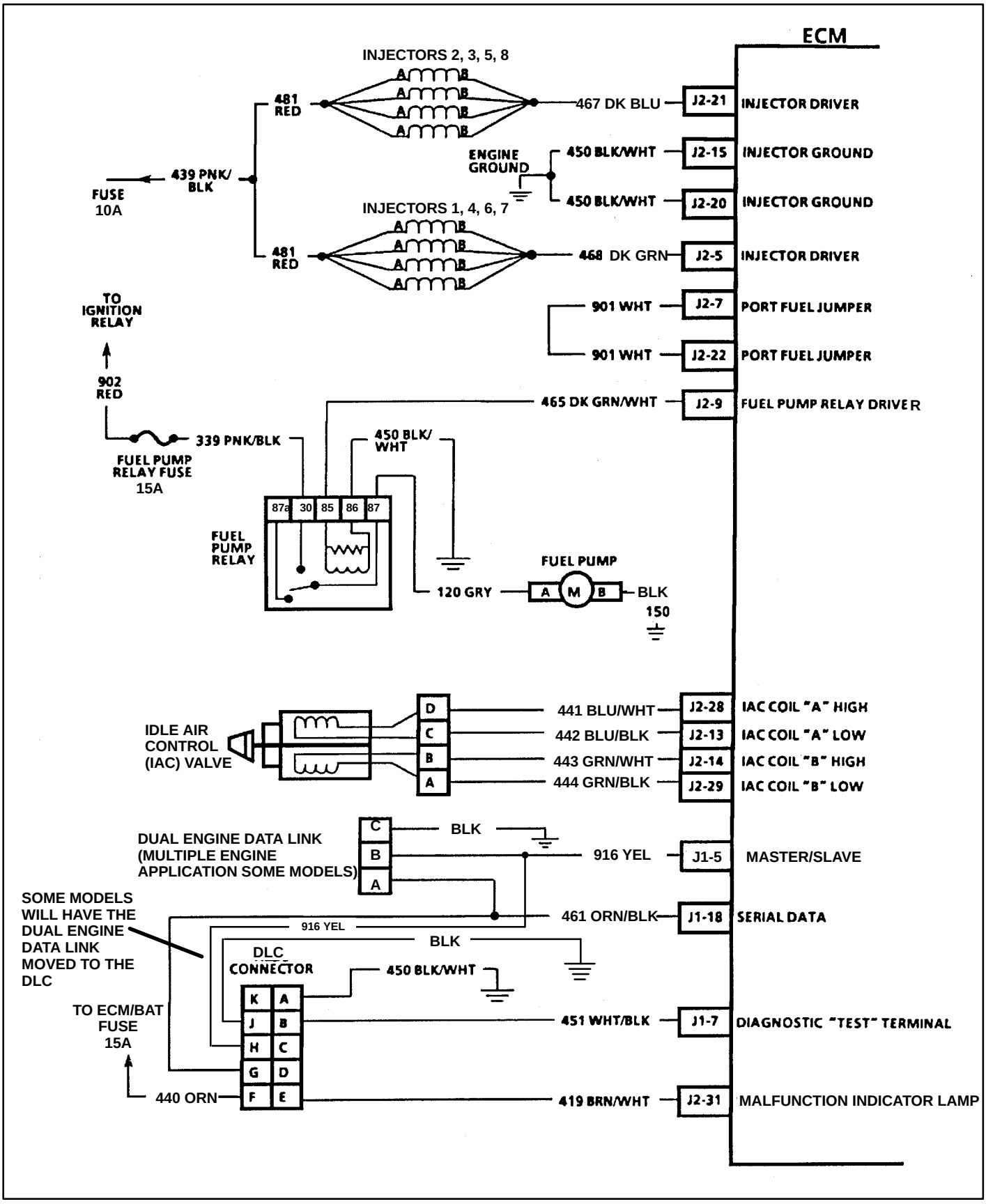
NOTE: All BLACK wires with a ground symbol are interconnected within the fuel injection system harness.

NOTE 1: As a mid year (1996-1/2) model change, the Multi Port Injection models have the lanyard stop connector removed from the wiring harness. The dual engine capability is relocated by routing the YEL wire to the Data Link Connector (DLC).

Index

1 -Vapor Separator Tank (VST)
2 -Throttle Body
3 -Distributor
4 -Coil
5 -Knock Sensor (KS) Module
6 -Data Link Connector (DLC)
7 -Manifold Absolute Pressure (MAP) Sensor
8 -Intake Air Temperature (IAT) Sensor
9 -Knock Sensor
10-Idle Air Control (IAC)
11-Throttle Position (TP) Sensor
12-Engine Coolant Temperature (ECT) Sensor
13-Electronic Control Module (ECM)
14-Fuel Pump Relay
15-Ignition Relay
16-Fuel Pump Fuse (15 Amp)
17-Injector Fuse (15 Amp) ECM, DLC, Battery
18-ECM Fuse (10 Amp) ECM/Ignition/Injector/ Knock Sensor Module
19-Harness Connector to Starting/Charging Harness
20-Harness Connector to Lanyard Stop Switch (Optional)
21-Harness Connector for Dual Engine Data Link Cable (1996-1/2 And Earlier Models)
22-Positive (+) Power Wire to Engine Circuit Breaker

Multi-Port Injection Wiring Diagram (Chart 1 Of 4)



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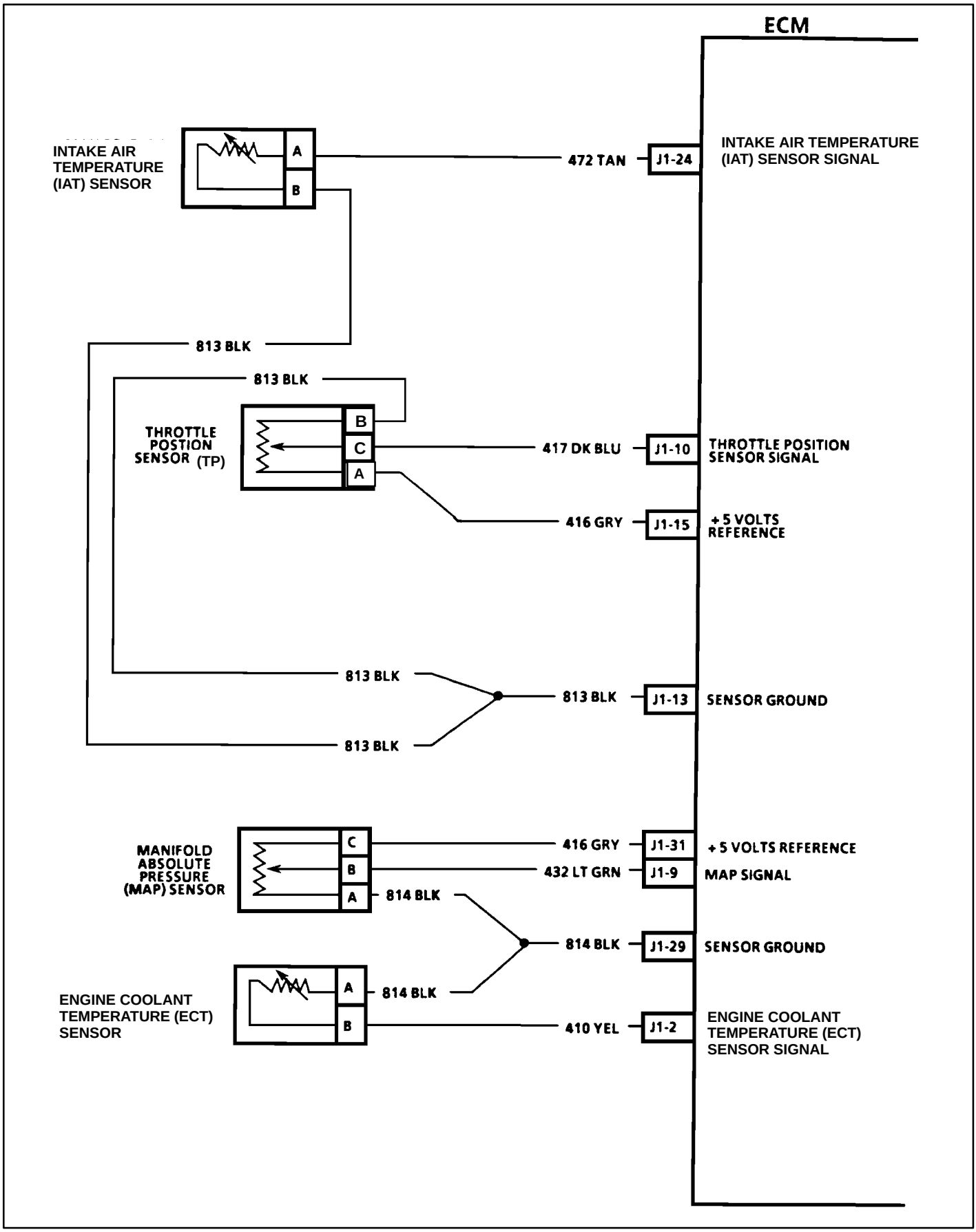
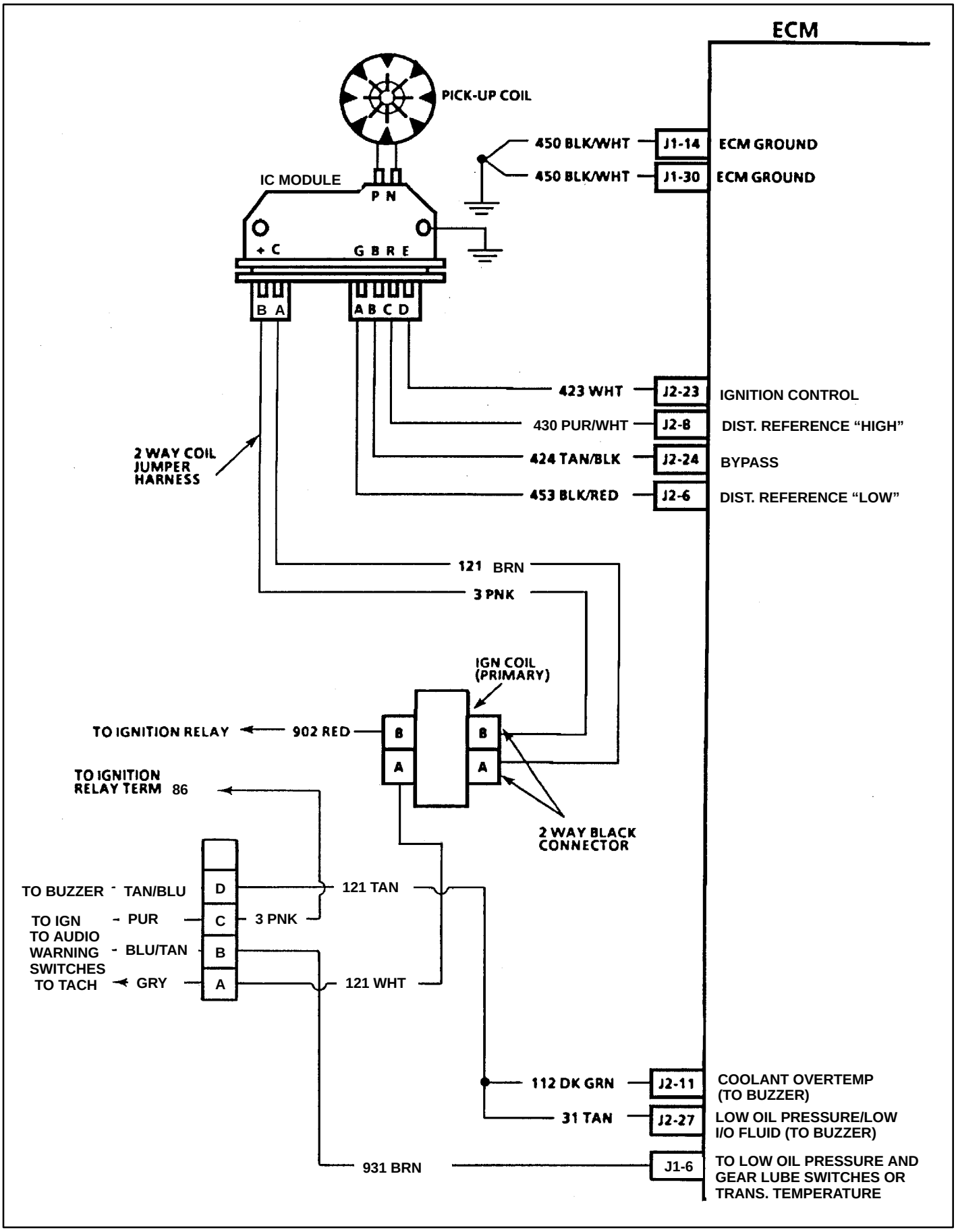
Multi-Port Injection Wiring Diagram (Chart 2 Of 4)



Multi-Port Injection Wiring Diagram (Chart 3 Of 4)



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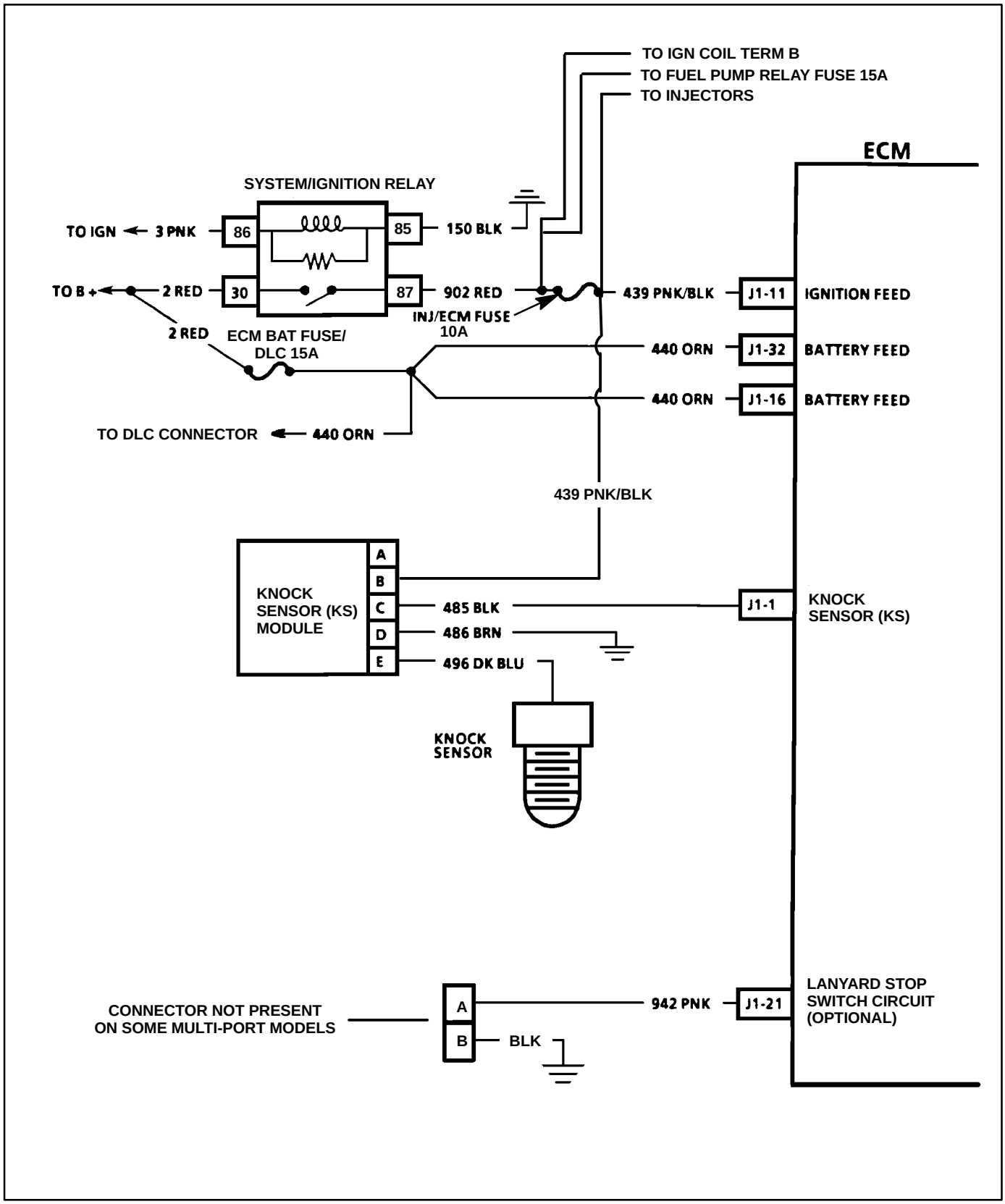
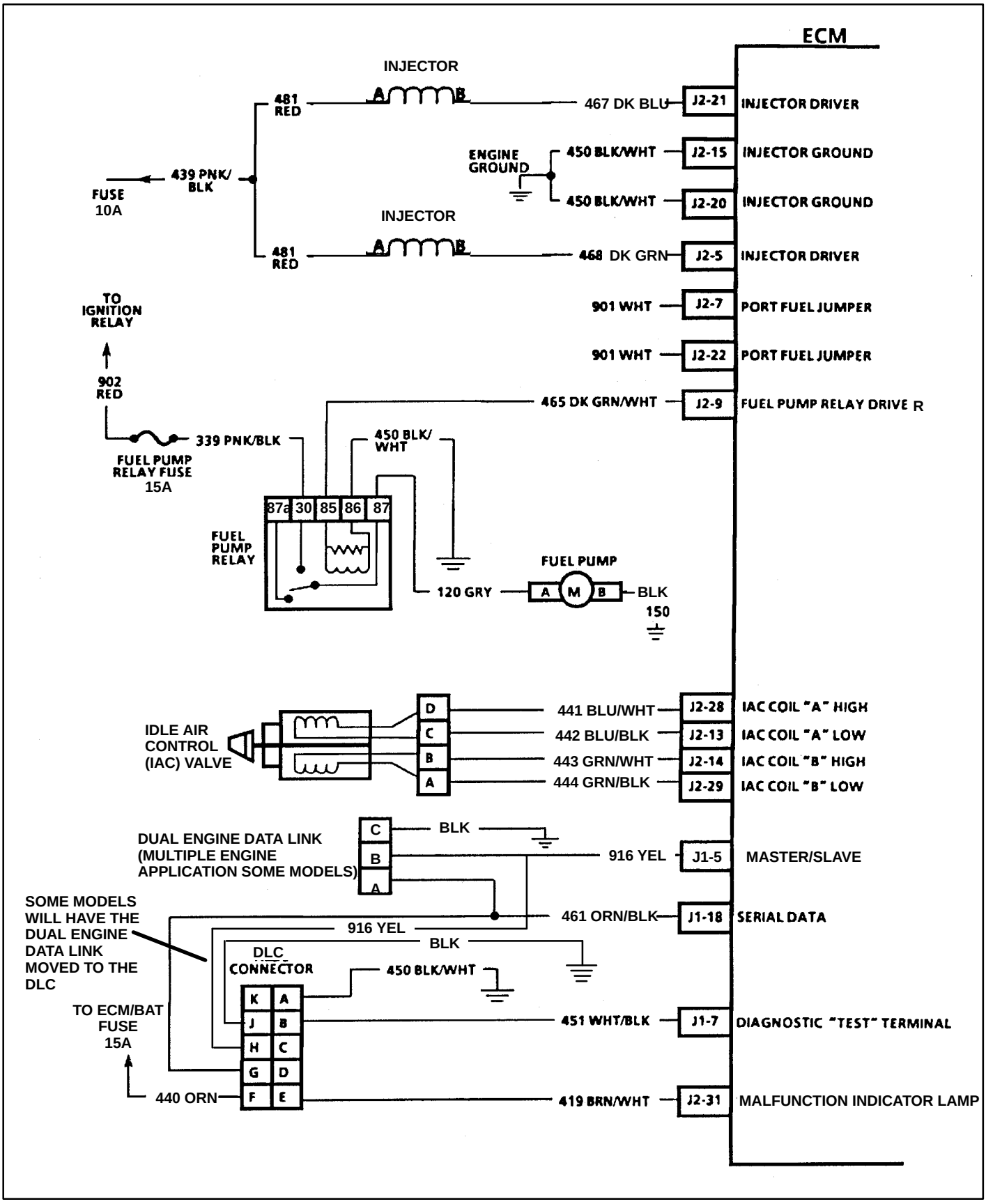
Multi-Port Injection Wiring Diagram (Chart 4 Of 4)



Throttle Body Injection Wiring Diagram (Chart 1 of 4)



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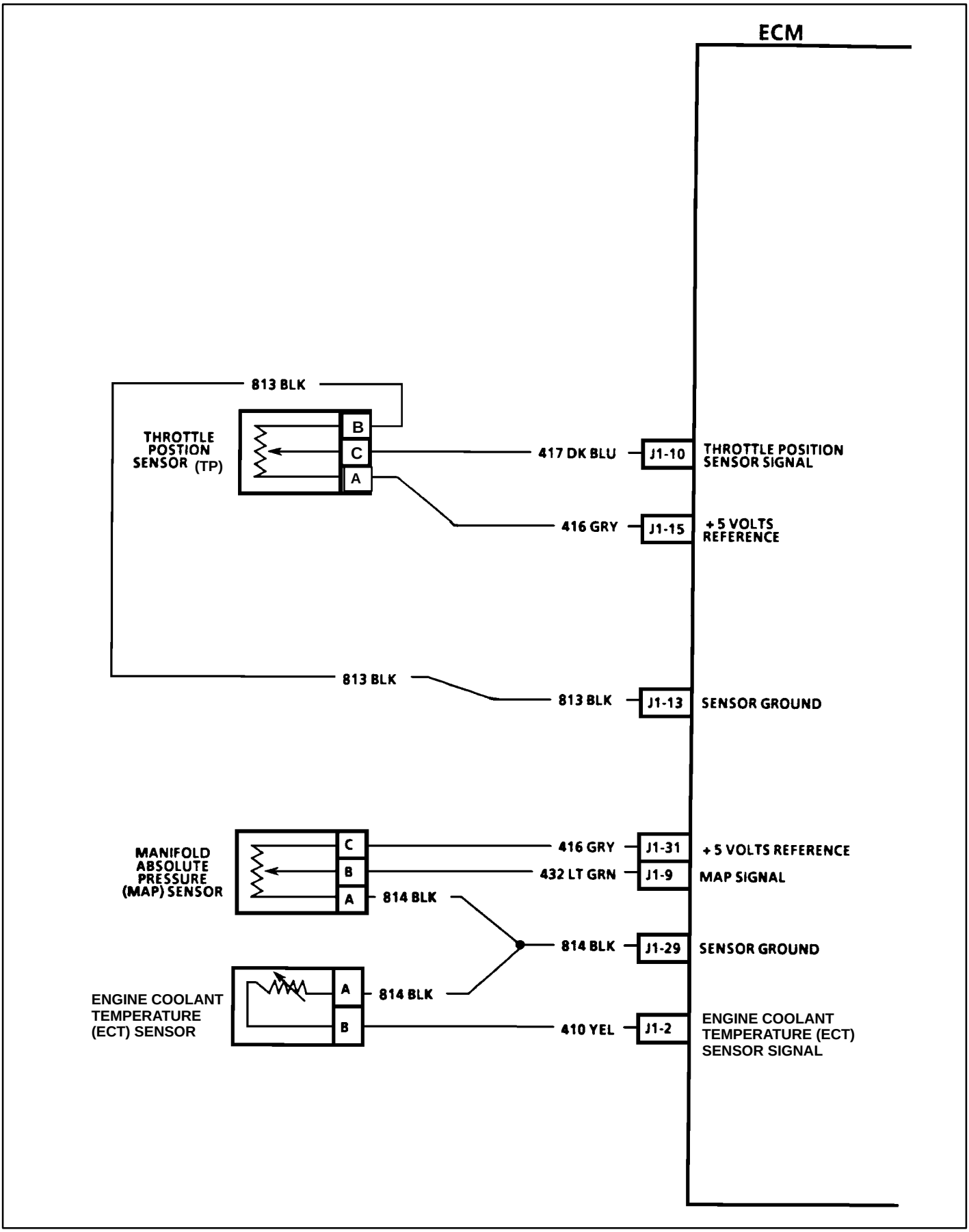
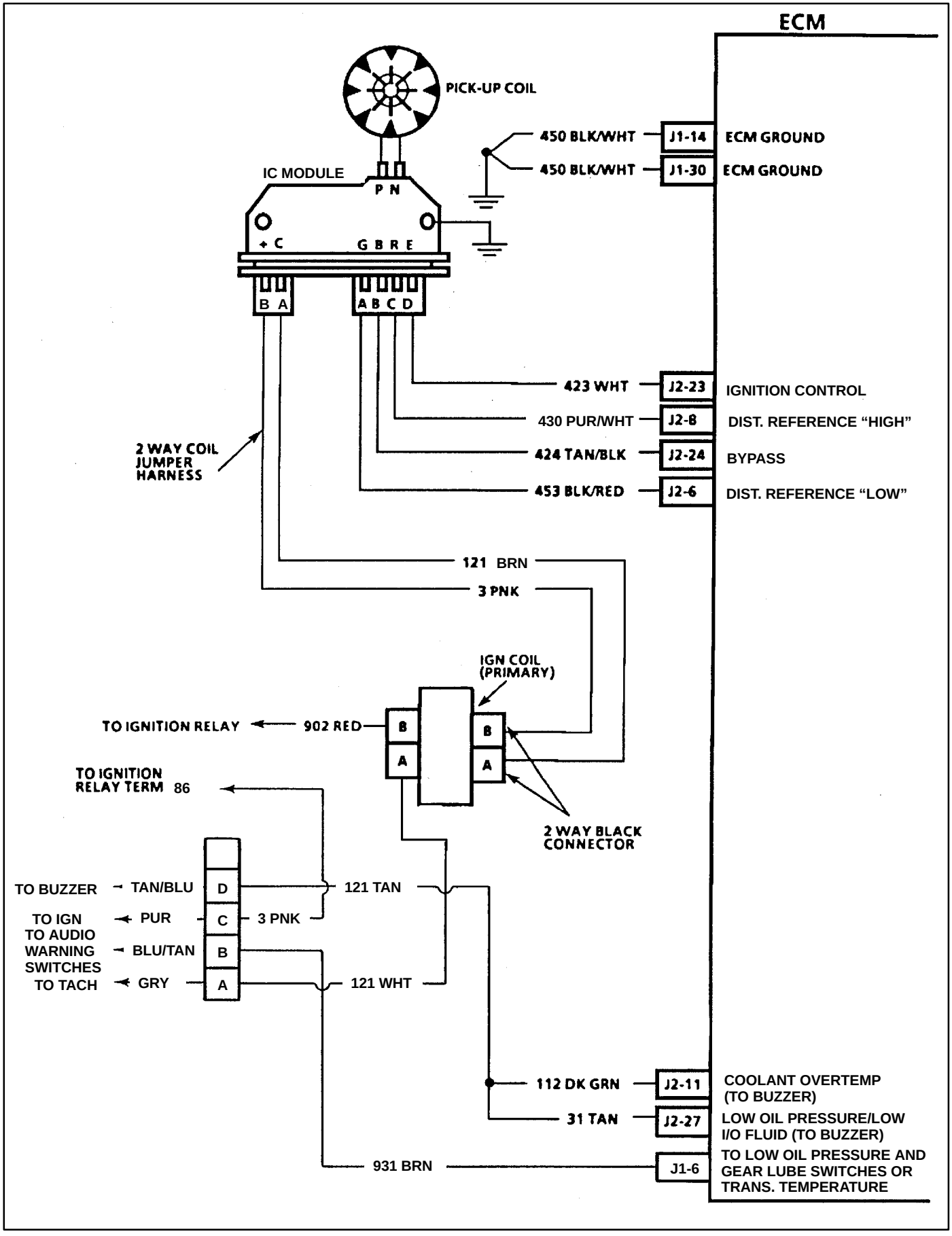
Throttle Body Injection Wiring Diagram (Chart 2 Of 4)



Throttle Body Injection Wiring Diagram (Chart 3 Of 4)



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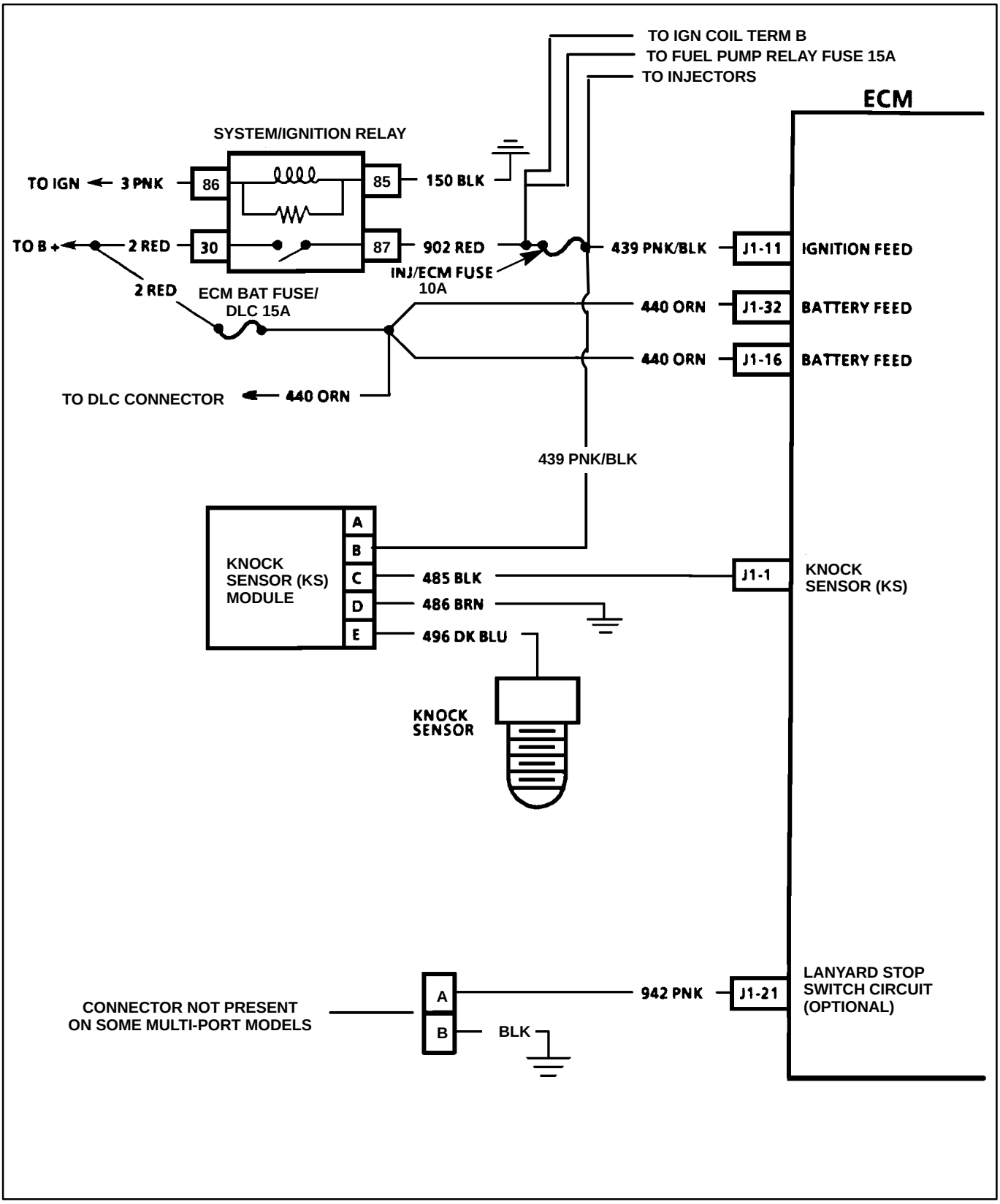
Throttle Body Injection Wiring Diagram (Chart 4 Of 4)



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Diagnostic Circuit Check

The Diagnostic Circuit Check is an organized approach to identifying a problem created by an electronic engine control system malfunction. It must be the starting point for any driveability complaint diagnosis because it directs the service technician to the next logical step in diagnosing the complaint.

NOTE: *A scan tool that displays faulty data should not be used, and the problem should be reported to the manufacturer. The use of a faulty scan tool can result in misdiagnosis and unnecessary parts replacement.*

The scan tool data listed in the table may be used for comparison. After completing the diagnostic circuit check and finding the on-board diagnostics functioning properly and no trouble codes displayed. The "Typical Data Values" are an average of display values recorded from normally operating vessels and are intended to represent what a normally functioning system would typically display.

Only the parameters listed below are used in this manual for diagnosing. If a scan reads other parameters, the values are not recommended for use in diagnosing. If all values are within the range illustrated, refer to "Troubleshooting."

Scan Tool Normal Specifications
(Idle / Warm Engine / Closed Throttle / Neutral)

Scan Position	Units Displayed	Typical Data Value
RPM	RPM	600-700 RPM
Desired RPM	RPM	600 RPM
Coolant Temp.	° F(° C)	150-170° F (66-77° C)
Manifold Air Temp.	° F (° C)	Varies with Ambient Temperature
Throttle Position	Volts	.4 to .8 Volts
Throttle Angle	0-100 %	0-1%
MAP	Volts or kPa	1-3 Volts or (45-55 kPa) (Depends on Vacuum and Baro Pressure)
Baro	Volts or kPa	3-5 Volts (Depends on Altitude and Barometric Pressure)
Bat	Volts	12.0-14.5 Volts
Spark Advance	Degrees	-10 to 30°
Knock Retard	Degrees	0°
Idle Air Control IAC	Counts (Steps)	0-40 Counts
Minimum IAC Position	Counts (Steps)	0-40 Counts
Idle Air Control Follower	Counts (Steps)	0 Counts
Injector Pulse Width	msec.	2-3 msec.
Injector On Time Cranking	msec.	2.5–3.5 msec. (Depends on Water/Air Temperature)
Fuel Consumption	GPH (L/h)	1-2 GPH(3.7-7.5 L/h)
Time From Start	0:00:00-1092:00	Varies
Memory Calibration Check Sum	Calibration and Check Sum	Varies with Software revision in ECM
Oil Press/IO Level (See Note)	OK/LO	OK
Engine Overtemp	OK/Overheating	OK
Power Reduction Mode	OFF/ON	OFF
Lanyard Stop Mode	OFF/ON	OFF

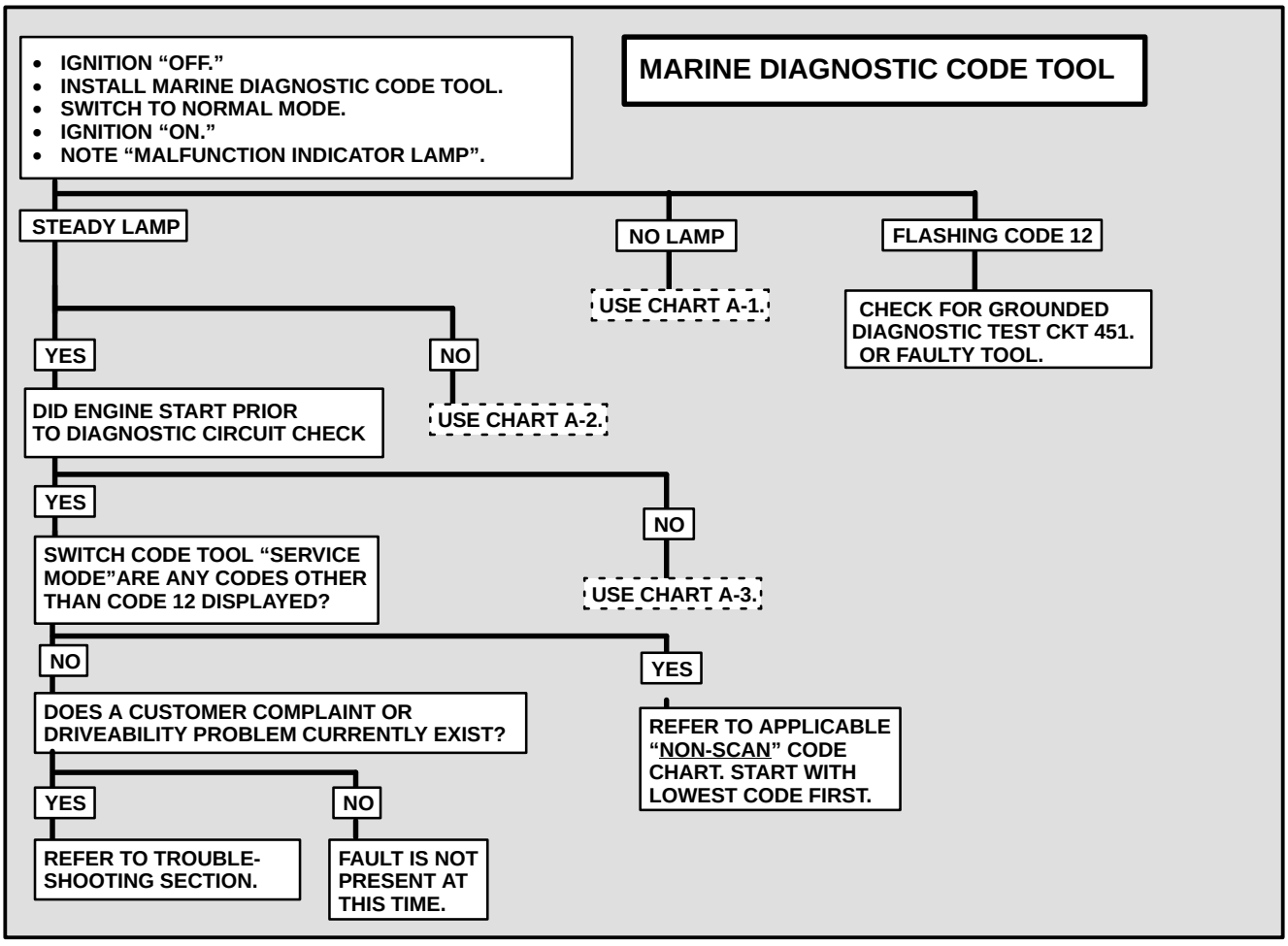
NOTE: MCM will read I/O Level and MIE will read Trans.

CLEARING CODES USING DIAGNOSTIC CODE TOOL (NON-SCAN)

1. Install diagnostic code tool.
2. Turn key ON.
3. Select service mode on code tool.
4. To clear codes, move the throttle, while in neutral, from 0% to 100% then back to 0%.
5. Exit “Service Mode” on code tool.
6. Start engine and let run for fifteen seconds.
7. Turn key OFF for 5 seconds.
8. Select “Service Mode” on code tool.
9. Turn key ON and read codes. If codes are still present, check note following and repeat from Step 1.
10. Refer to appropriate Troubleshooting and/or Diagnostic Charts

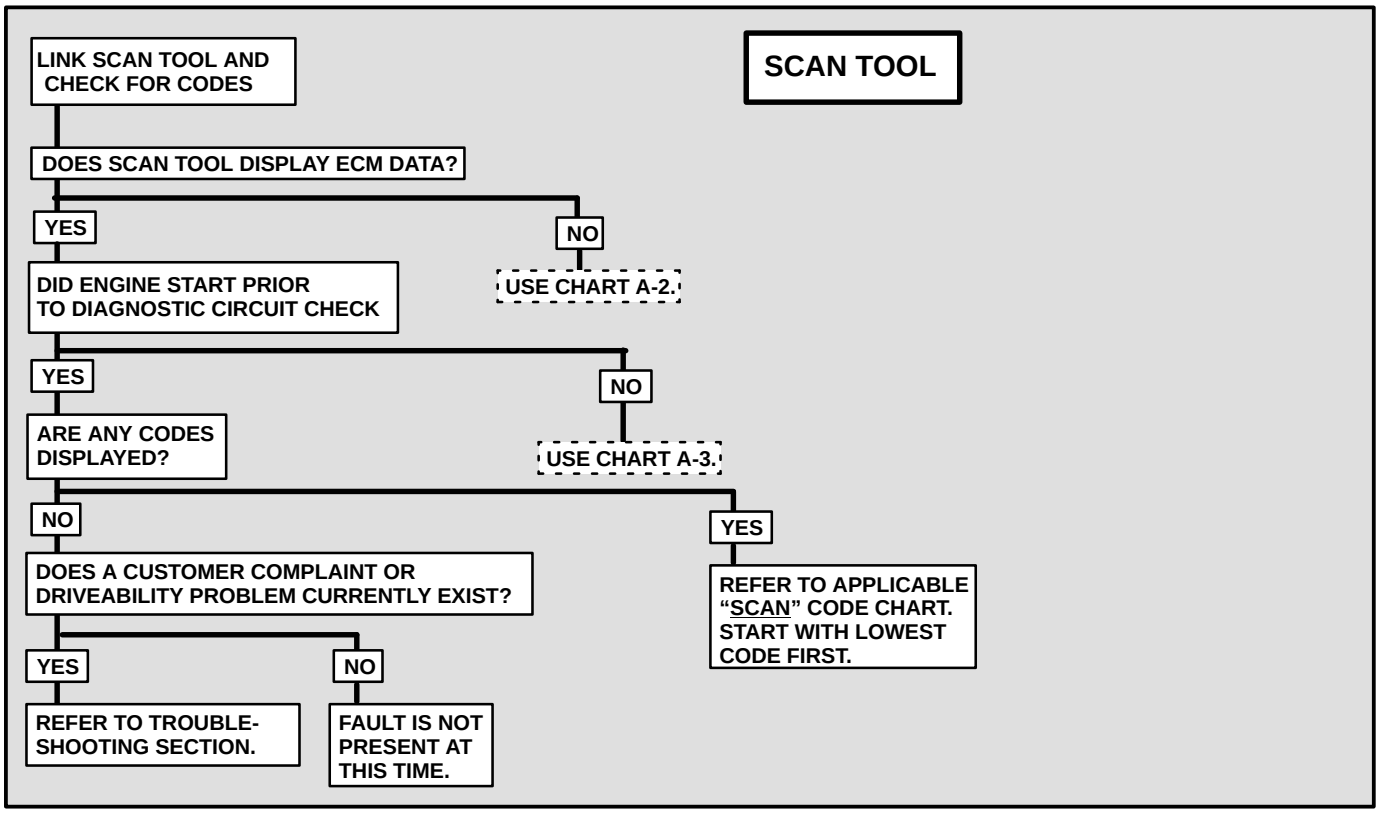
NOTE: *When clearing codes without the use of a scan tool, the battery must be fully charged and cranking speed must be at least 300 RPM. The ability to clear codes is directly dependent on the battery being fully charged and able to start the engine with adequate cranking RPM.*

A poorly charged battery or engine cranking problem may result in an ECM “reset” and may not allow stored trouble codes to be cleared from EEPROM memory. If this condition exists, BE SURE the battery is fully charged. If a low battery condition does exists the audio warning buzzer will come on for 2 seconds after engine start-up.

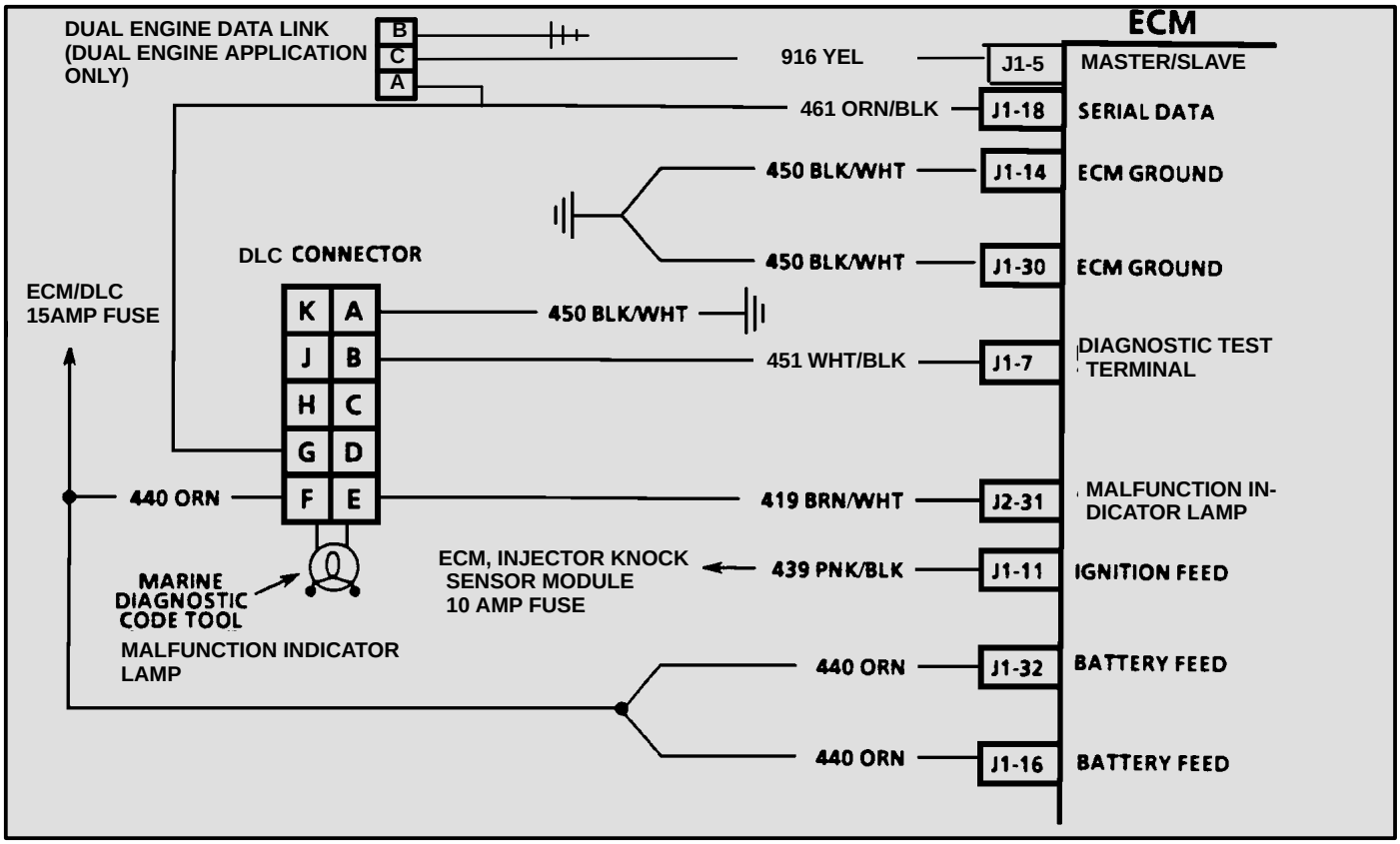


CLEARING CODES USING SCAN TOOL (SCAN)

1. Connect scan tool.
2. Start engine.
3. Select clear codes function.
4. Clear codes.
5. Turn key OFF.
6. Turn key ON and read codes. If codes are still present, (there is a real fault in system) check note preceding and repeat Step 1.



No “Malfunction Indicator Lamp” (Marine Diagnostic Code Tool Installed)
Chart A-1 (1 of 2)



CIRCUIT DESCRIPTION:

There should always be a steady “Malfunction Indicator Lamp” when the ignition is ON and engine stopped. Ignition voltage is supplied directly to the light bulb. The Electronic Control Module (ECM) will control the light and turn it ON by providing a ground path through CKT 419 to the ECM.

TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. This step insures that battery voltage is available to terminal “F” of the DLC connector.
2. This step checks for ground present in DLC connector terminal “E.” This indicates that the ECM is capable of completing the ground to the “Malfunction Indicator Lamp”.
3. This step isolates the cause of incomplete ground to either a wiring or ECM circuitry.
4. If the engine fails to crank, this may indicate a failure in the starting system circuit.

DIAGNOSTIC AIDS:

Engine runs OK, check:

- Faulty light bulb.
- CKT 419 open.

Engine cranks but will not run, check:

- Continuous battery - 50 amp circuit breaker open.
- Open ECM fuse.
- Battery circuit to ECM open.
- Ignition circuit to ECM open.
- Poor connection to ECM.
- Faulty ECM ground circuit(s).

Engine will not crank.

- Perform EFI system relay check.

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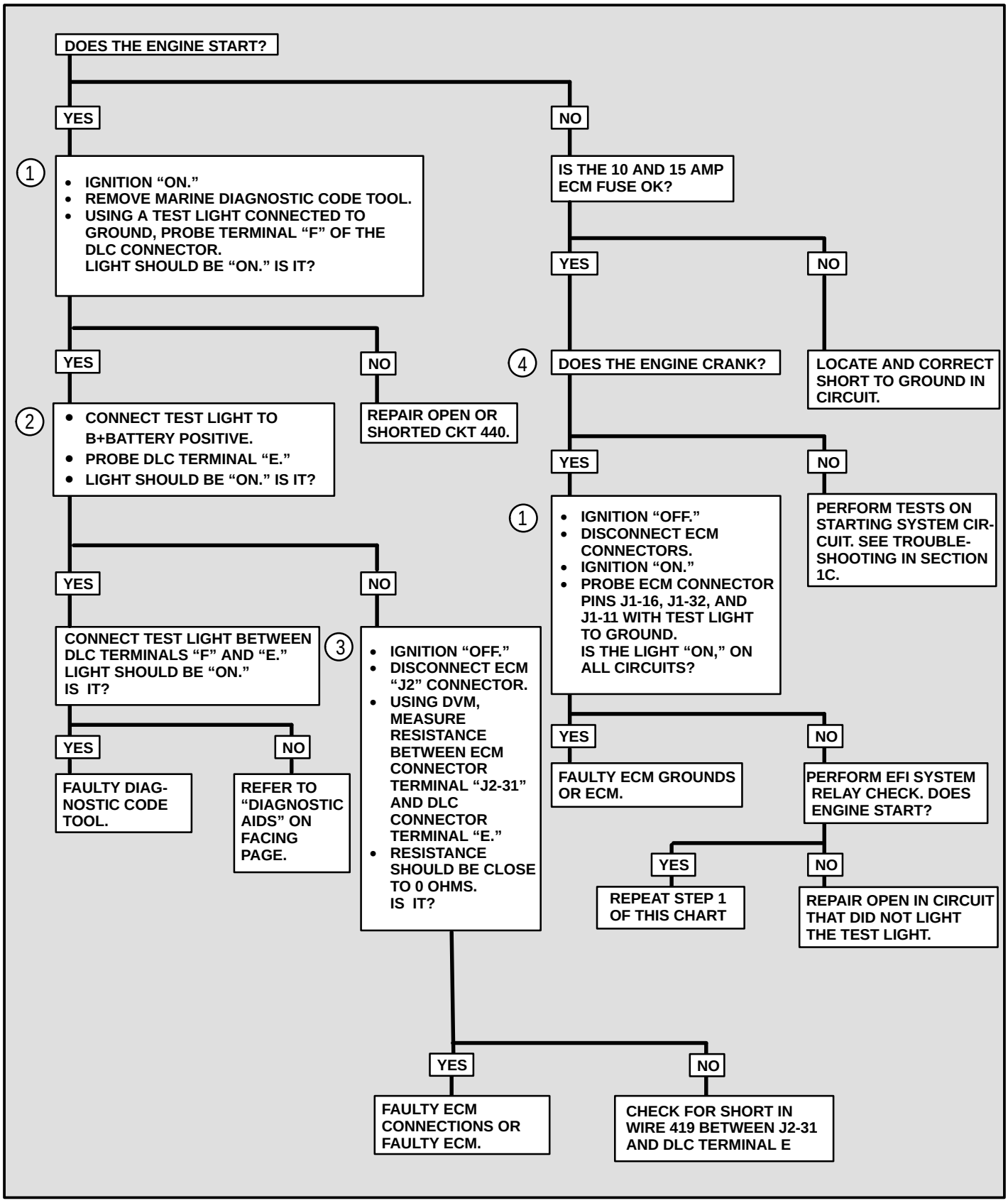
No “Malfunction Indicator Lamp”
Chart A-1: (2 of 2)



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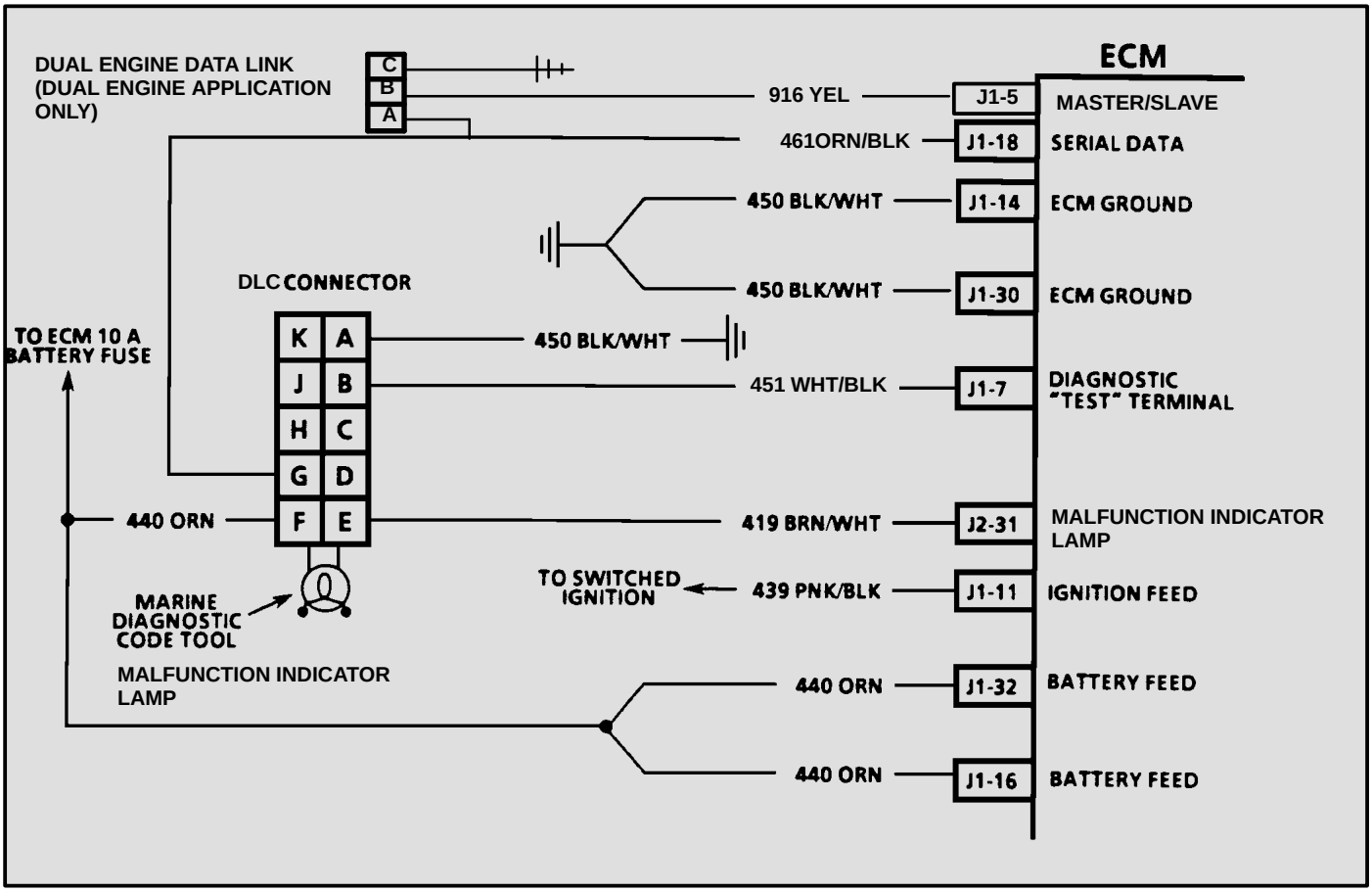
No DLC Data or Will Not Flash Code 12 “Malfunction Indicator Lamp” On Steady (Marine Diagnostic Code Tool Installed)
Chart A-2 (1 of 2)



CIRCUIT DESCRIPTION:

There should always be a steady “Malfunction Indicator Lamp” when the ignition is ON and engine stopped. Ignition voltage is supplied to the light bulb. The Engine Control Module (ECM) will turn the lamp ON by grounding CKT 419 in the ECM.

With the diagnostic “test” terminal grounded CKT 419, the lamp should flash a Code 12, followed by any trouble code(s) stored in memory.

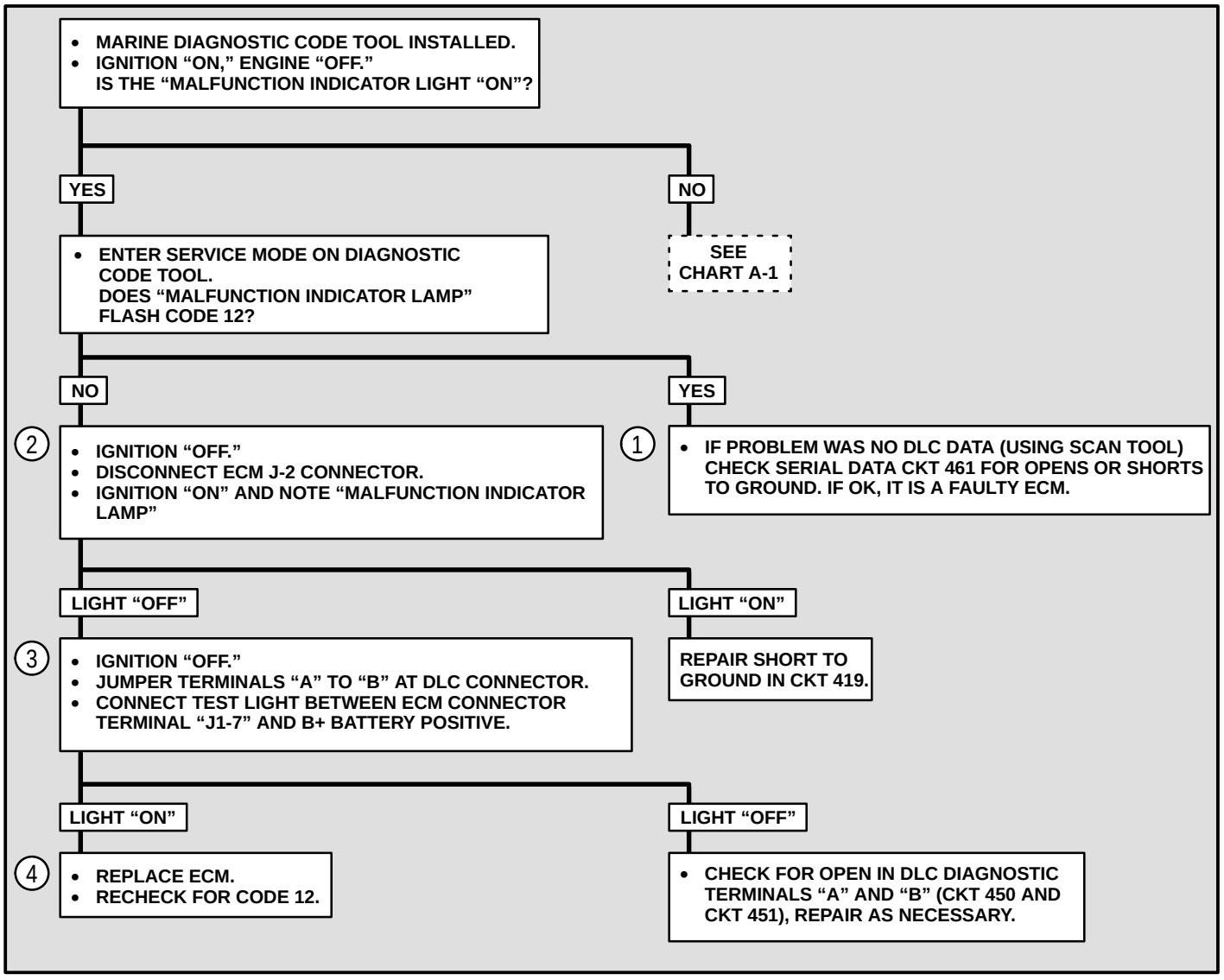
A steady light suggests a short to ground in the lamp control CKT 419 or an open in diagnostic CKT 451.

TEST DESCRIPTION:

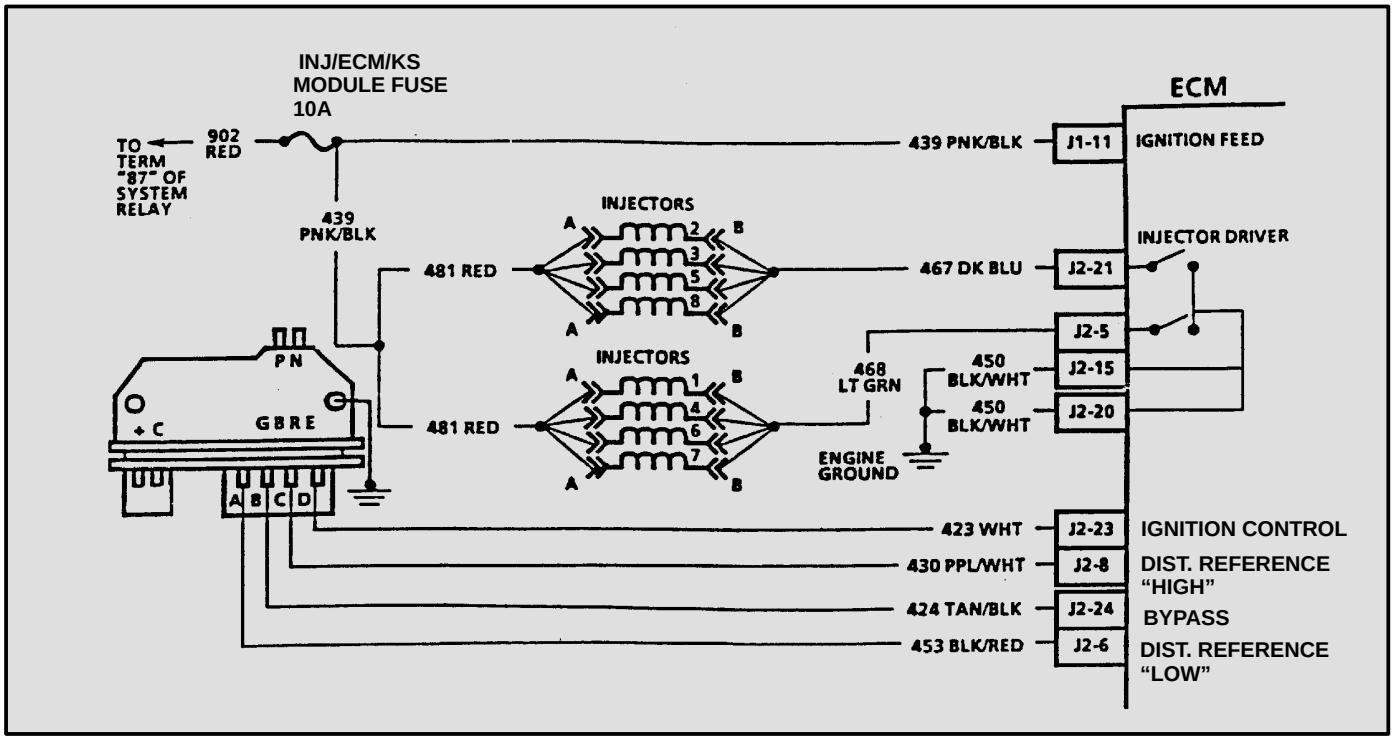
Number(s) below refer to circled number(s) on the diagnostic chart.

1. If there is a problem with the ECM that causes a scan tool to not read serial data, the ECM should not flash a Code 12. If Code 12 is flashing, check CKT 451 for short to ground. If Code 12 does flash, make sure that the scan tool is working properly on another engine.
2. If the light goes OFF when the ECM connector is disconnected, CKT 419 is not shorted to ground.
3. This step will check for an open diagnostic CKT 451.
4. At this point, the “Malfunction Indicator Lamp” wiring is OK. If Code 12 does not flash, the ECM should be replaced.

No DLC Data or Will Not Flash Code 12
Chart A-2: (2 of 2)



Engine Cranks but Will Not Run Chart A-3 (1 of 4)



CIRCUIT DESCRIPTION:

This chart assumes that battery condition and engine cranking speed are OK, and there is adequate fuel in the tank.

TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. An ECT sensor that indicates coolant temperature less than actual temperature can flood the engine with fuel. An ECT sensor that indicates coolant temperature greater than actual can starve the engine of fuel. If the TP sensor is at 50 to 75% of its range, the engine may be in the clear flood mode, which will cause starting problems. The engine will not start without reference pulses and, therefore, the scan tool should read engine RPM (reference) during cranking.
2. No spark may be caused by one of several components related to the high energy ignition/IC system. The ignition system will address all problems related to the causes of a no spark condition.
3. The test light should blink, indicating the ECM is controlling the injectors OK.
4. All injectors should be within 1.0 ohm of each other and should not be less than 12 ohms at 70°F (21°C). If an injector is suspected for a no start condition, unhook the suspected injector and try to start the engine.
5. Use fuel pressure gauge 91-16850 or J-34730-1. Wrap a shop towel around the fuel pressure tap to absorb any small amount of fuel leakage that may occur when installing the gauge.

DIAGNOSTIC AIDS:

- Unless engine enters “Clear Flood” at the first indication of a flooding condition, it can result in a no start.
- Check for fouled plugs.
- Water or foreign material in fuel line, VST, water separating fuel filter can cause a no start in cold weather.
- A defective MAP sensor may cause a no start or a stall after start. To determine if the sensor is causing the problem, disconnect it. The ECM will then use a default value for the sensor, and if the condition is corrected and the connections are OK, replace the sensor.
- Using injector harness test light (J-34730-2A) check for blinking light at injector harness on both banks of the engine. If not OK, check injector fuses.

If above are all OK, refer to “Troubleshooting.”

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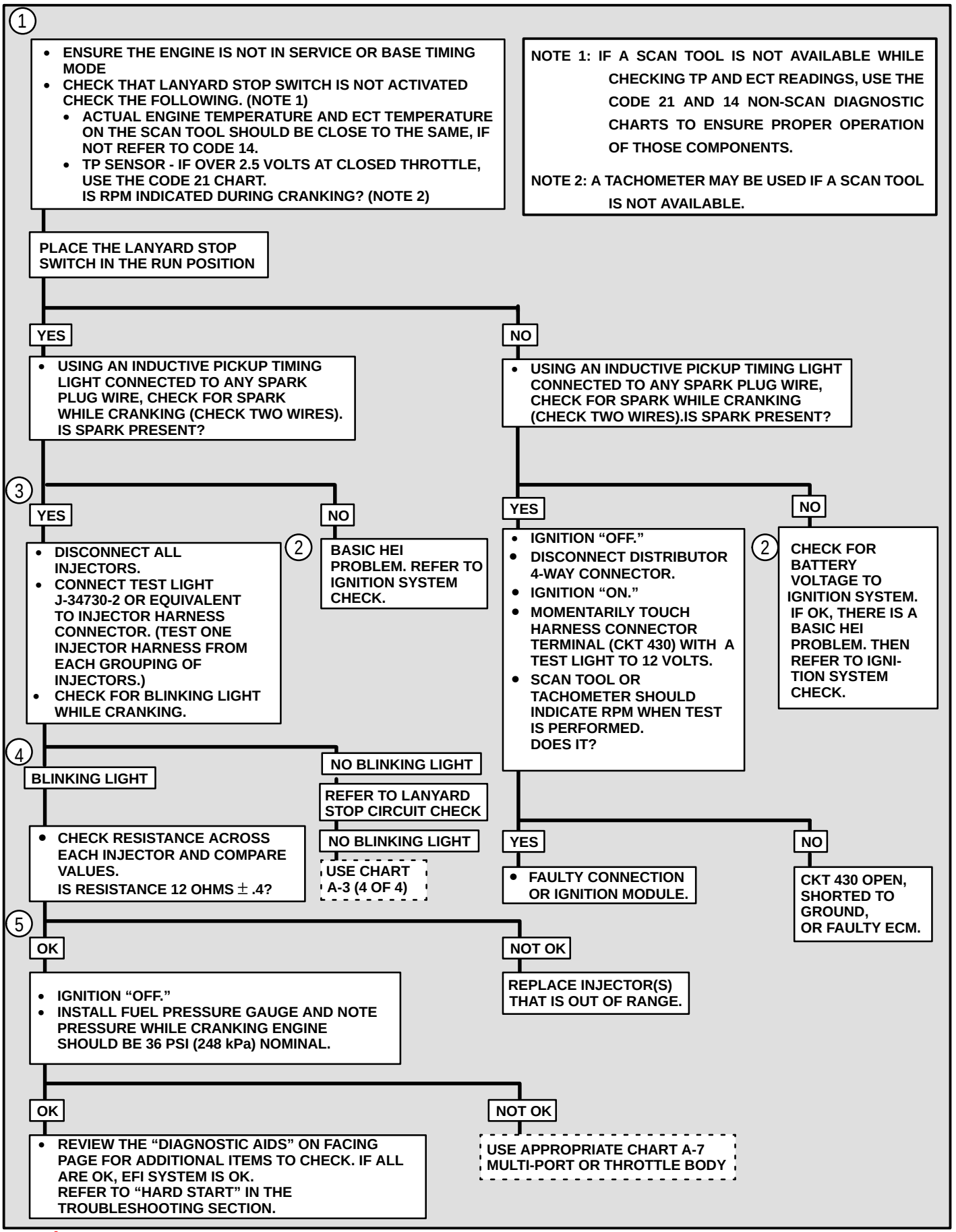
Engine Cranks but Will Not Run (Continued)
Chart A-3: (2 of 4)



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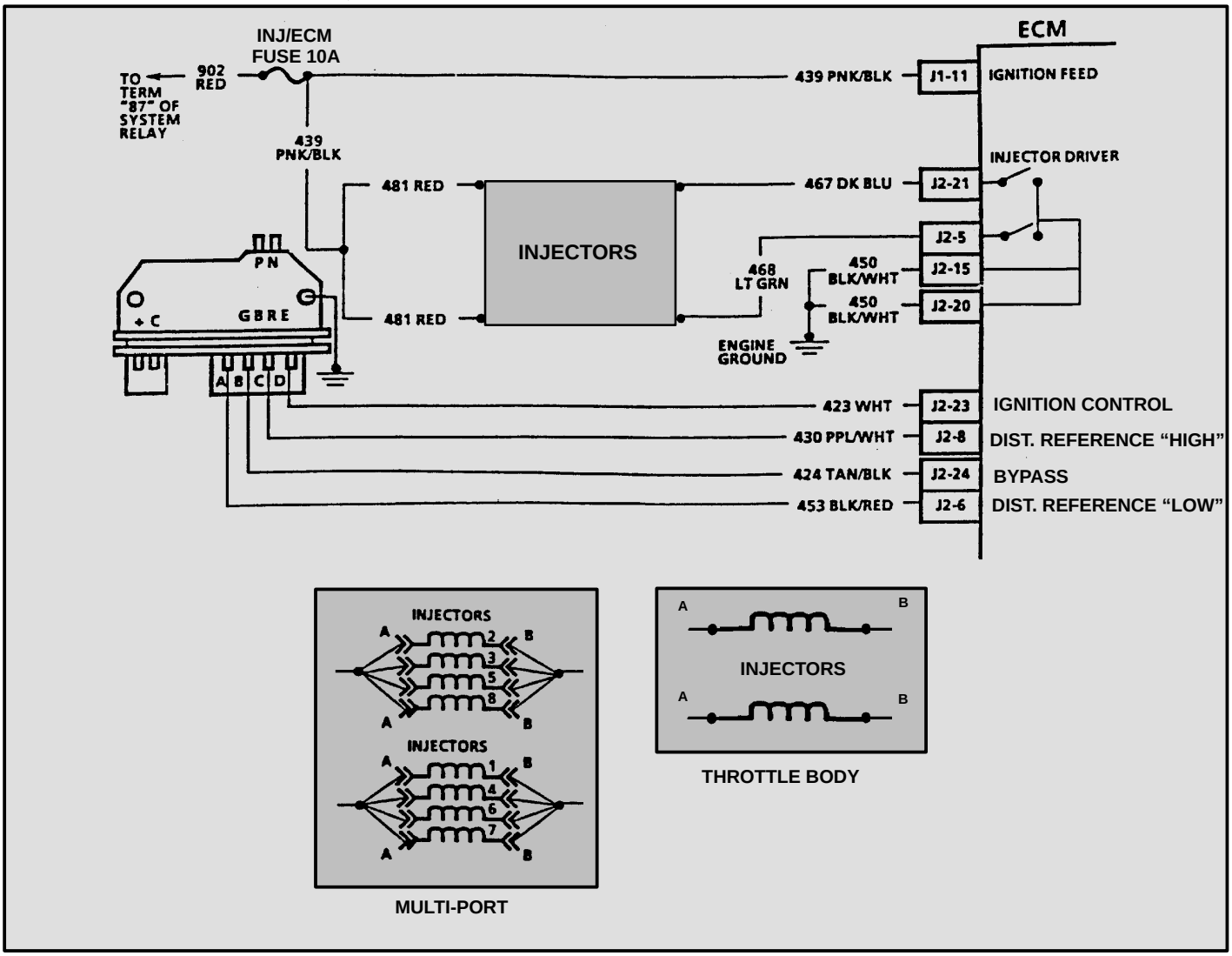
Engine Cranks but Will Not Run (Continued)
Chart A-3 (3 of 4)



TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. Check for 12 volt supply to injectors. Due to the injectors wired in parallel, there should be a light ON on both terminals.
2. Check continuity of CKT 467 and CKT 468.
3. All checks made to this point would indicate that the ECM is at fault. However, there is a possibility of CKT 467 or CKT 468 being shorted to a voltage source either in the engine harness or in the injector harness.

To test for this condition:

- Disconnect all injectors.
- Ignition ON.
- Probe CKT 467 and CKT 468 on the ECM side of injector harness with a test light connected to ground. (Test one injector harness on each side of engine.) There should be no light. If light is ON, repair short to voltage.
- If OK, check the resistance of the injectors. Should be 12 ohms $\pm$ 4.
- Check injector harness connector. Be sure terminals are not backed out of connector and contacting each other.
- If all OK, replace ECM.

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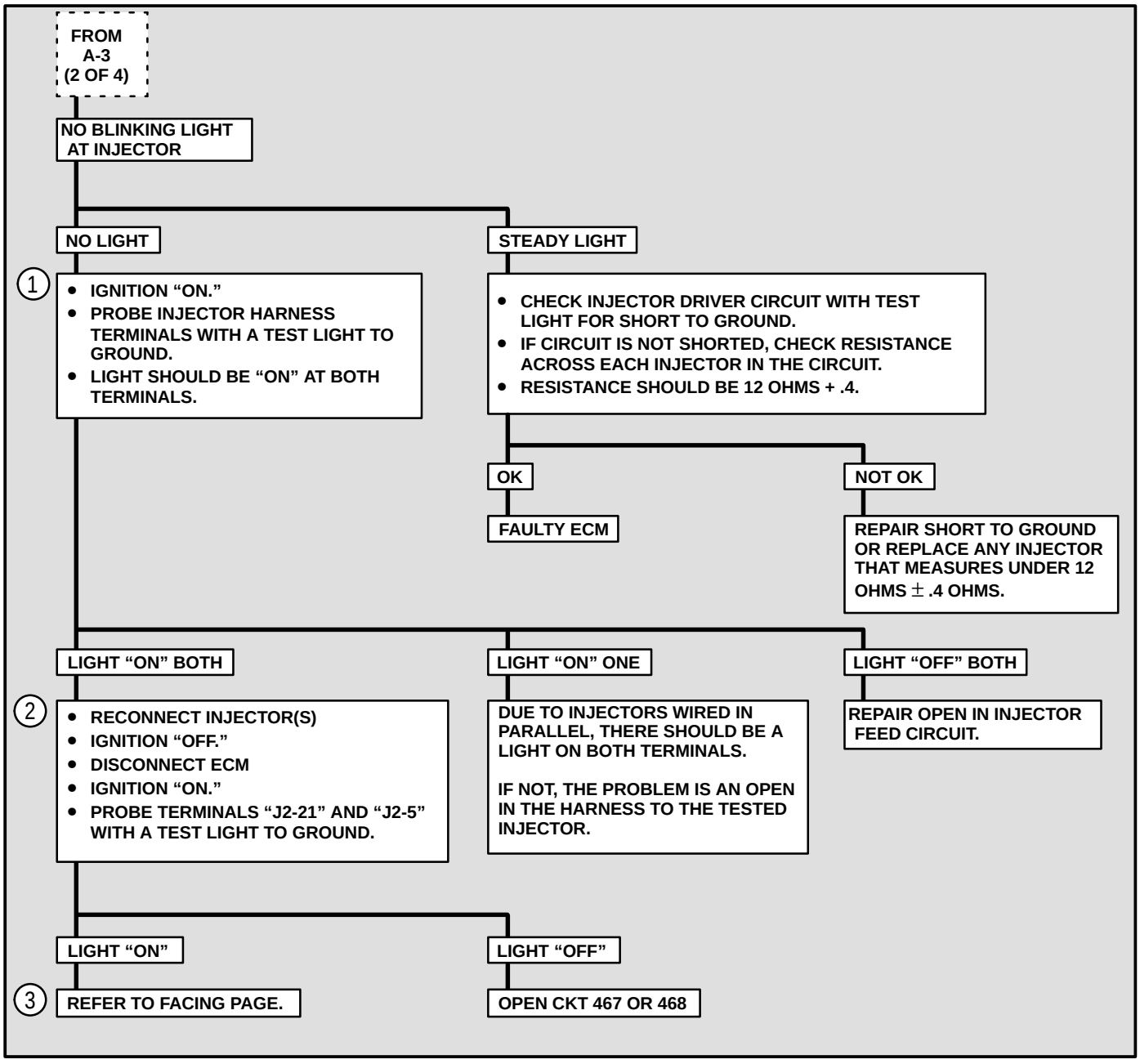
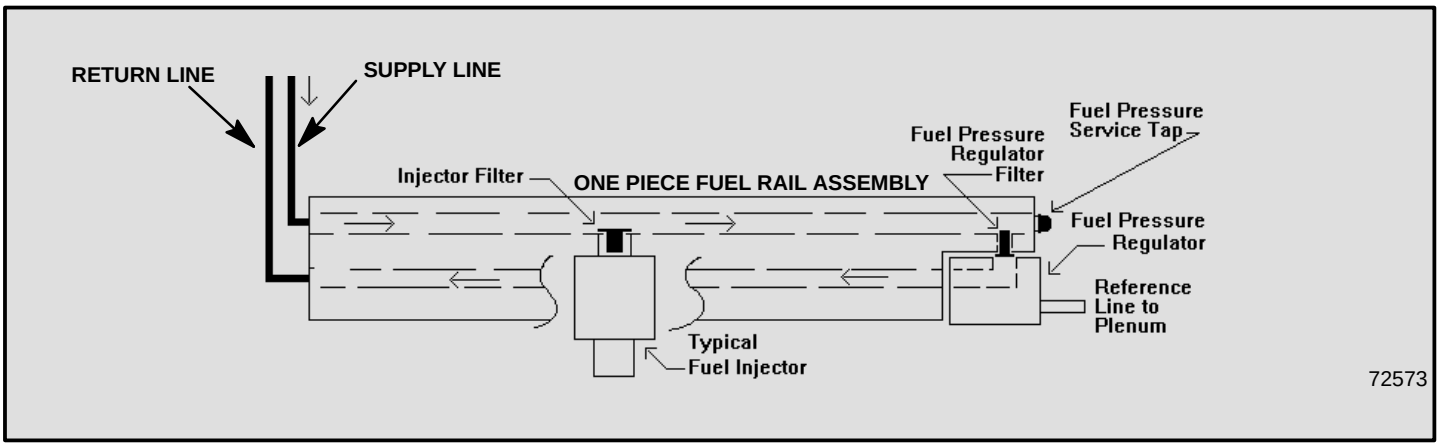
Engine Cranks but Will Not Run (Continued)
Chart A-3: (4 of 4)



Multi-Port Injection Fuel System Diagnosis
Chart A-7 (1 of 6)



CIRCUIT DESCRIPTION:

During engine cranking, the Engine Control Module (ECM) will turn ON the electric fuel pump in the vapor separator tank. It will remain ON as long as the engine is cranking or running, and the ECM is receiving reference pulses. If there are no reference pulses, the ECM will shut OFF the fuel pump.

The pump will deliver fuel to the fuel rail and injectors, then to the pressure regulator, where the system pressure is controlled to about 36 PSI (248 kPa) nominal. Excess fuel is then returned to the vapor separator tank.

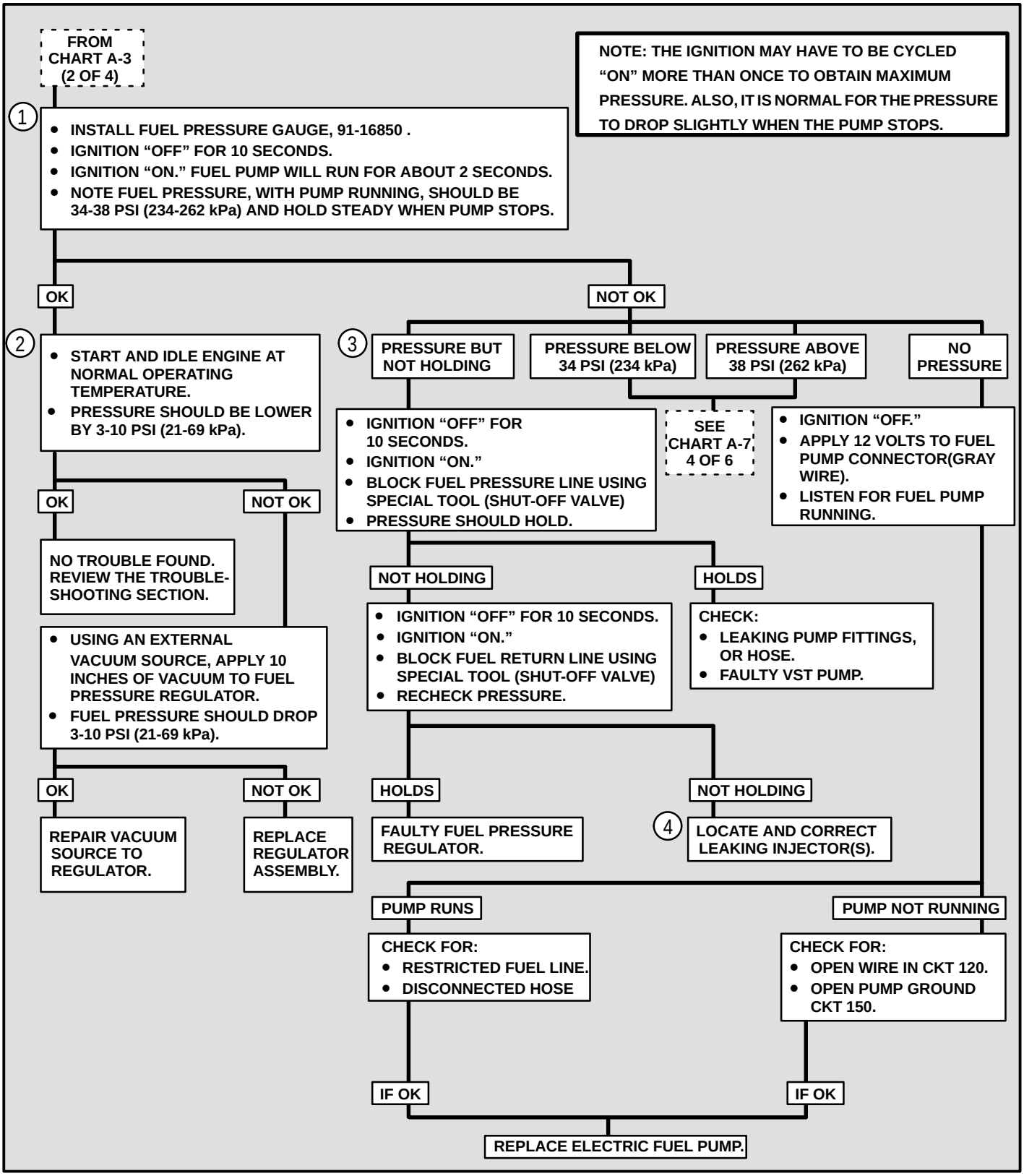
TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. If pump does not run check fuel pump relay and fuse.
2. Wrap a shop towel around the fuel pressure connector to absorb any small amount of fuel leakage that may occur when installing the gauge.

   Ignition ON, pump pressure should be 34-38 PSI (234-262 kPa). This pressure is controlled by spring pressure within the regulator assembly.
3. When the engine is idling, high vacuum is applied to the fuel regulator diaphragm. This will offset the spring and result in a lower fuel pressure. This idle vacuum will vary somewhat depending on barometric pressure; however, the fuel pressure at idle should be less, indicating fuel pressure regulator control.
4. Pressure that leaks down is caused by one of the following:
   - Fuel pressure regulator valve leaking.
   - Injector(s) sticking open.
   - Check vent line from VST to see if diaphragm is leaking.
5. If an injector is stuck open, it will send fuel to its respective cylinder, which may saturate or foul spark plug(s). In order to determine which injector is leaking, the spark plugs must be removed and inspected for fouling or saturation. Once the saturated spark plug(s) is found, replace the corresponding injector(s) and install new spark plug(s).

Multi-Port Injection Fuel System Diagnosis (Continued)
Chart A-7: (2 of 6)



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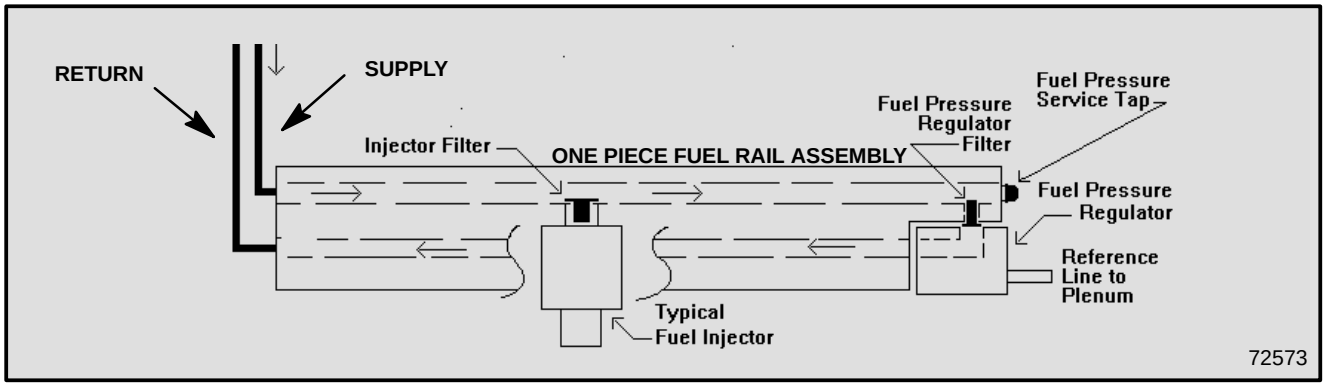
Multi-Port Injection Fuel System Diagnosis (Continued)
Chart A-7 (3 of 6)



Check for contaminated fuel tank, struck anti siphon valve or vacuum leak anywhere before the mechanical fuel pump. Also possible slipping seawater/fuel pump drive belt.

TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. Pressure less than 34 PSI (234 kPa) falls into two areas:

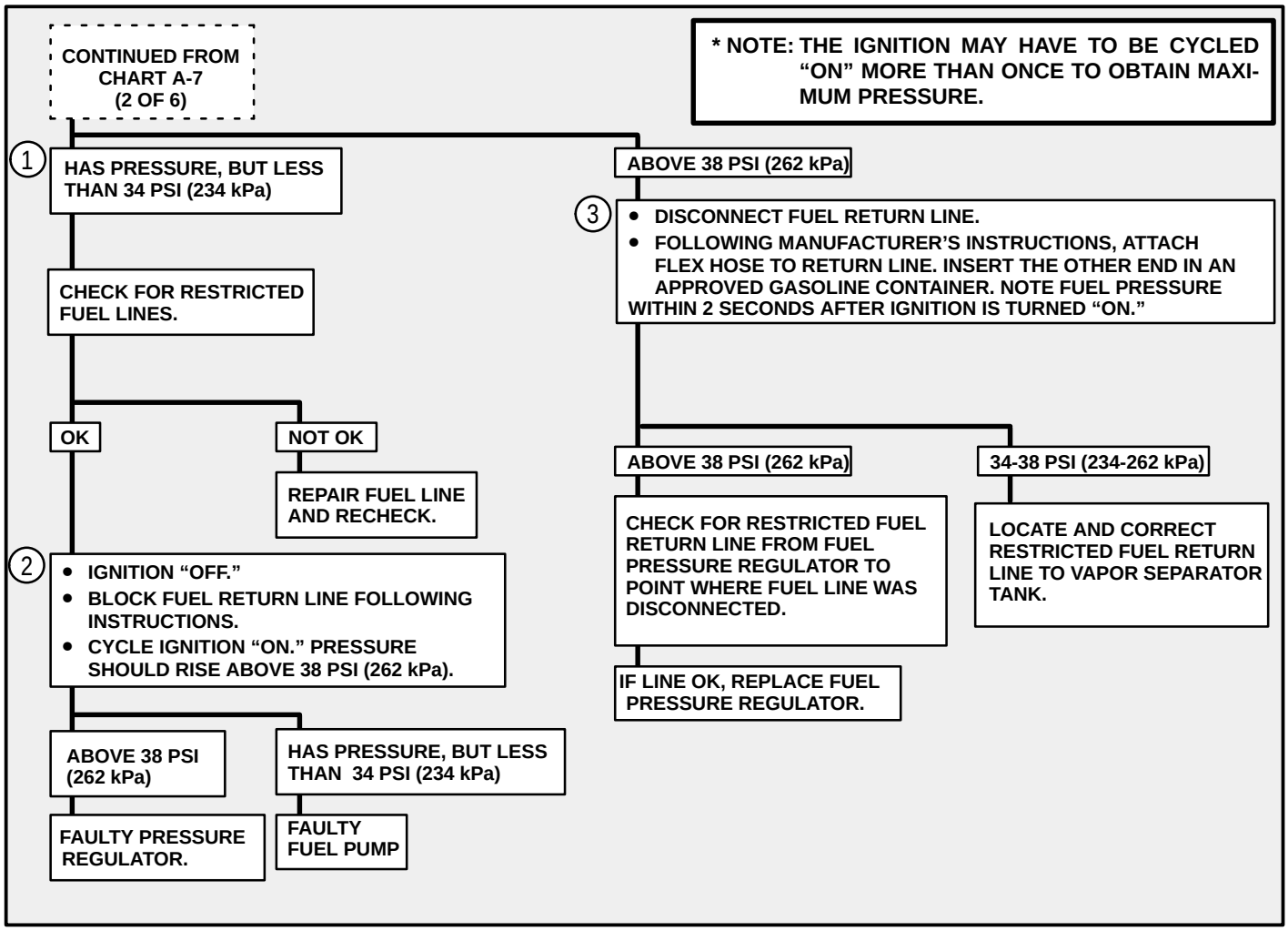
- Regulated pressure less than 34 PSI (234 kPa). The system will be running lean. Also, hard starting when cold and overall poor performance will be noticed.
- Restricted flow causing pressure drop. Normally, an engine with a fuel pressure of less than 24 PSI (165 kPa) at idle will not be driveable. However, if the pressure drop occurs only while underway, the engine will surge then stop running as pressure begins to drop rapidly. This is most likely caused by a restricted fuel line or plugged water separating fuel filter.

2. Restricting the fuel return line (Using Special Tool - Shut-Off Valve) allows the fuel pressure to build above regulated pressure. With battery voltage applied to the fuel pump, pressure should rise to 60 PSI (414 kPa) as the fuel return hose is gradually pinched.

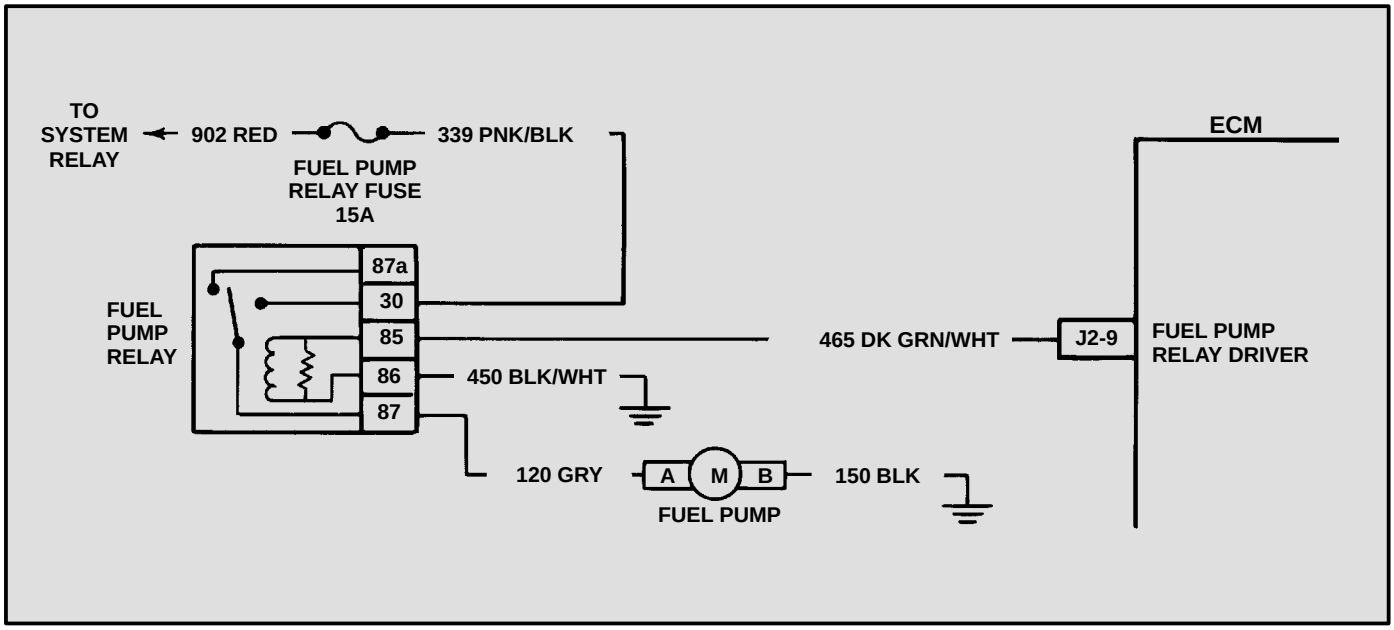
NOTE: *Do not allow fuel pressure to exceed 60 PSI (414 kPa); damage to the pressure regulator may result.*

3. This test determines if the high fuel pressure is due to a restricted fuel return line or a pressure regulator problem.

Multi-Port Injection Fuel System Diagnosis (Continued)
Chart A-7: (4 of 6)



Multi-Port Injection Fuel System Diagnosis (Continued)
Chart A-7 (5 of 6)



TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. This step checks if there is power to the fuel pump relay.
2. Bypassing the relay circuit should cause the fuel pump to run. This step should identify if the fault is in the relay or in the fuel pump circuit.
3. This step checks if there is an open in the ground circuit.
4. This step checks if the ECM is functioning properly.

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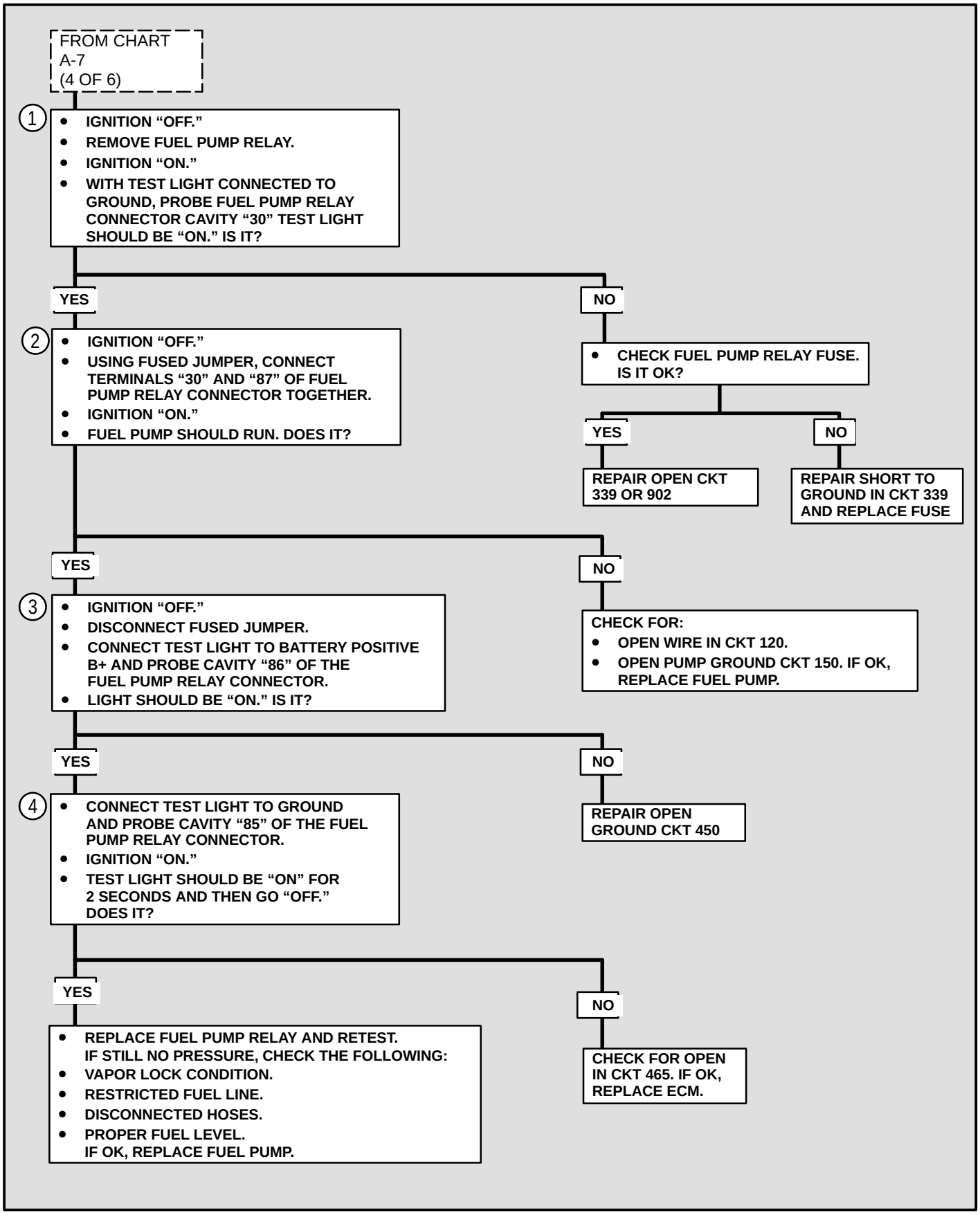
Multi-Port Injection Fuel System Diagnosis (Continued)
Chart A-7: (6 of 6)



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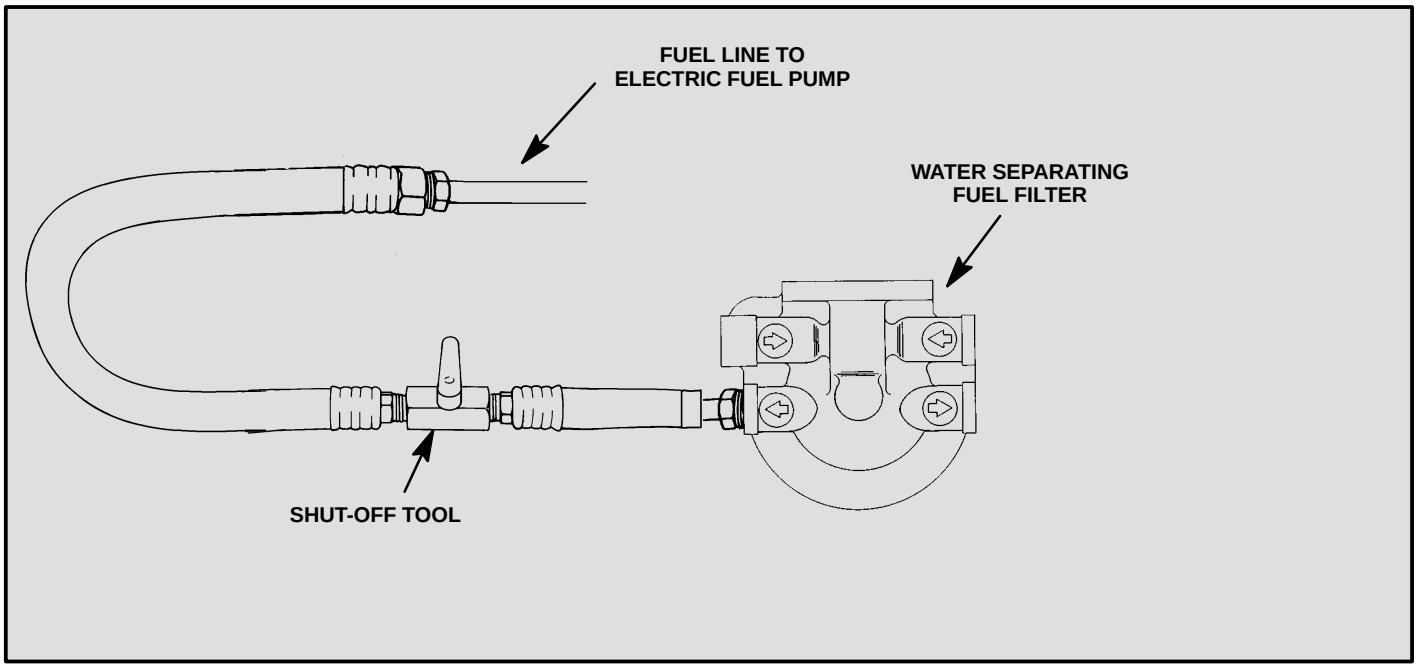
Throttle Body Injection Fuel System Diagnosis
Chart A-7 (1 of 6)



IMPORTANT: Check for contaminated fuel tank, stuck anti-siphon valve or fuel system vacuum leak anywhere before the electrical fuel pump and after the fuel pressure regulator.

CIRCUIT DESCRIPTION:

During engine cranking, the Engine Control Module (ECM) will turn ON the electric fuel pump. It will remain ON as long as the engine is cranking or running, and the ECM is receiving reference pulses. If there are no reference pulses, the ECM will shut OFF the fuel pump.

The pump will deliver fuel to the injectors and pressure regulator, where the system pressure is controlled to about 30 PSI (207 kPa) nominal. Excess fuel is then returned to the water separating fuel filter.

TEST DESCRIPTION:

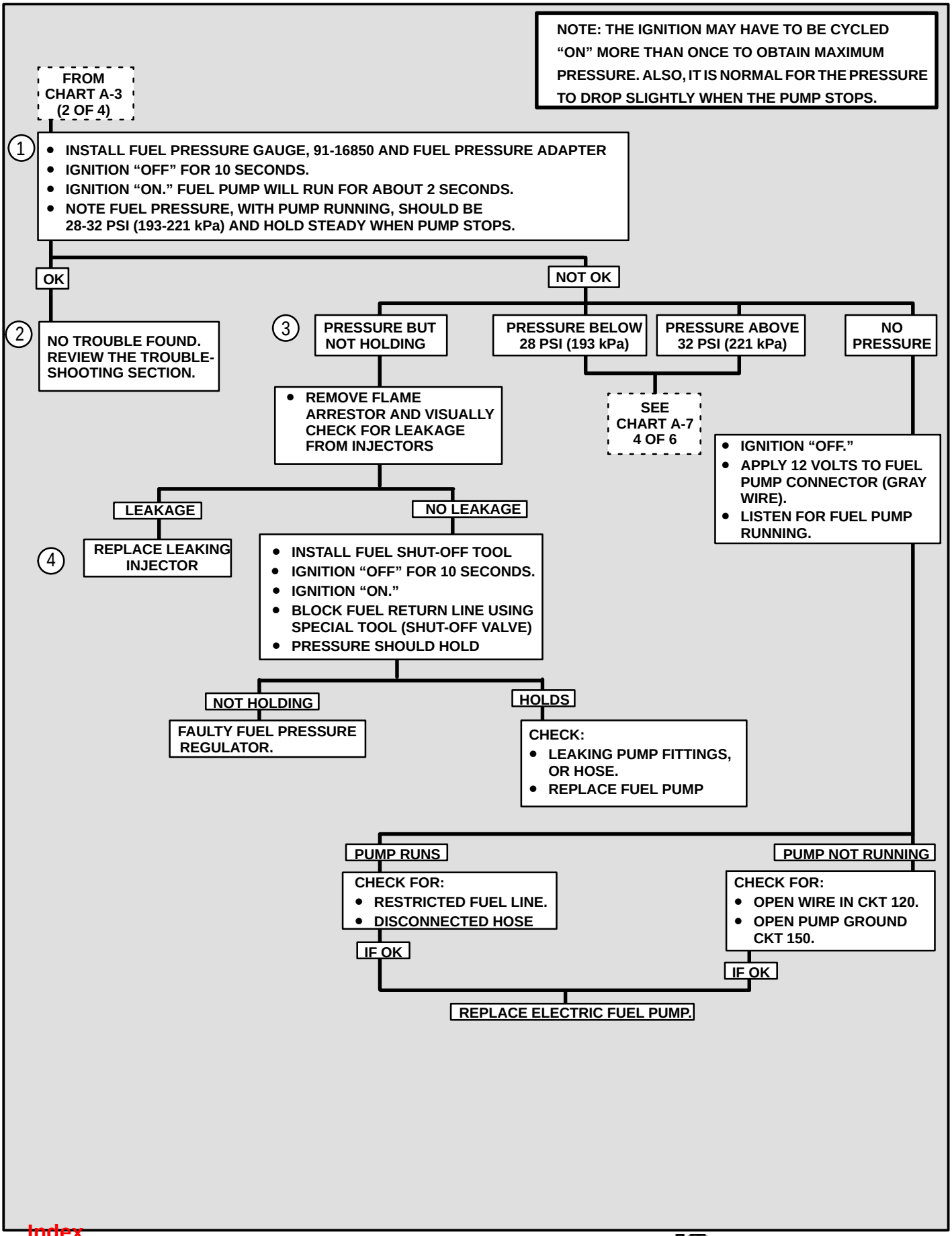
Number(s) below refer to circled number(s) on the diagnostic chart.

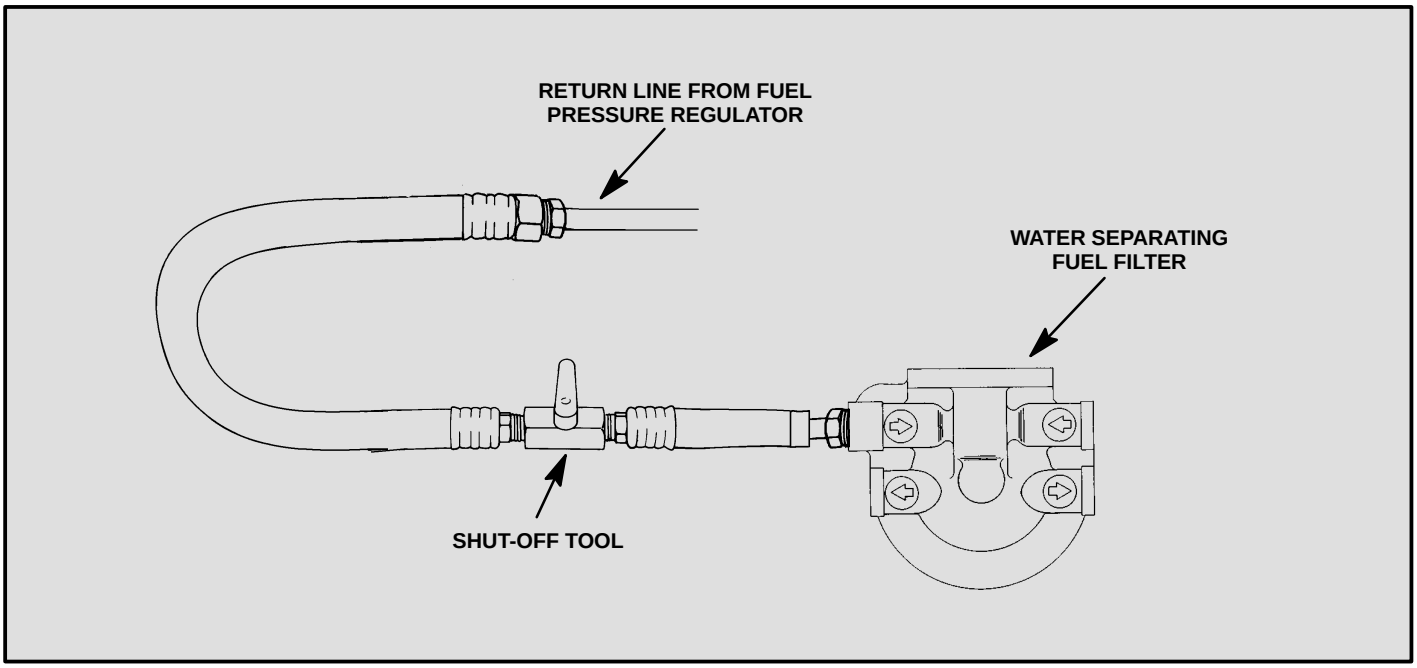
NOTE: *If pump does not run, check fuel pump relay and fuse.*

1. Install the fuel pressure adapter in-line at the throttle body.
2. Wrap a shop towel around the fuel pressure connector to absorb any small amount of fuel leakage that may occur when installing the gauge.

   Ignition ON, pump pressure should be 28-32 PSI (234-207 kPa). This pressure is controlled by spring pressure within the regulator assembly.
3. Pressure that leaks down is caused by one of the following:
   - Fuel pressure regulator valve leaking.
   - Injector(s) sticking open.
   - Check valve in fuel pump leaking.
4. An injector that is stuck open will leak or drip fuel into the plenum of intake manifold, which may saturate or foul spark plug(s). In order to determine which injector is leaking, remove the flame arrestor and observe both fuel injectors with “key on” and “engine off”.

Throttle Body Injection Fuel System Diagnosis (Continued)
Chart A-7: (2 of 6)





IMPORTANT: Check for contaminated fuel tank, stuck anti-siphon valve or fuel system vacuum leak anywhere before the electrical fuel pump and after the fuel pressure regulator.

TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. Pressure less than 28 PSI (193 kPa) falls into two areas:

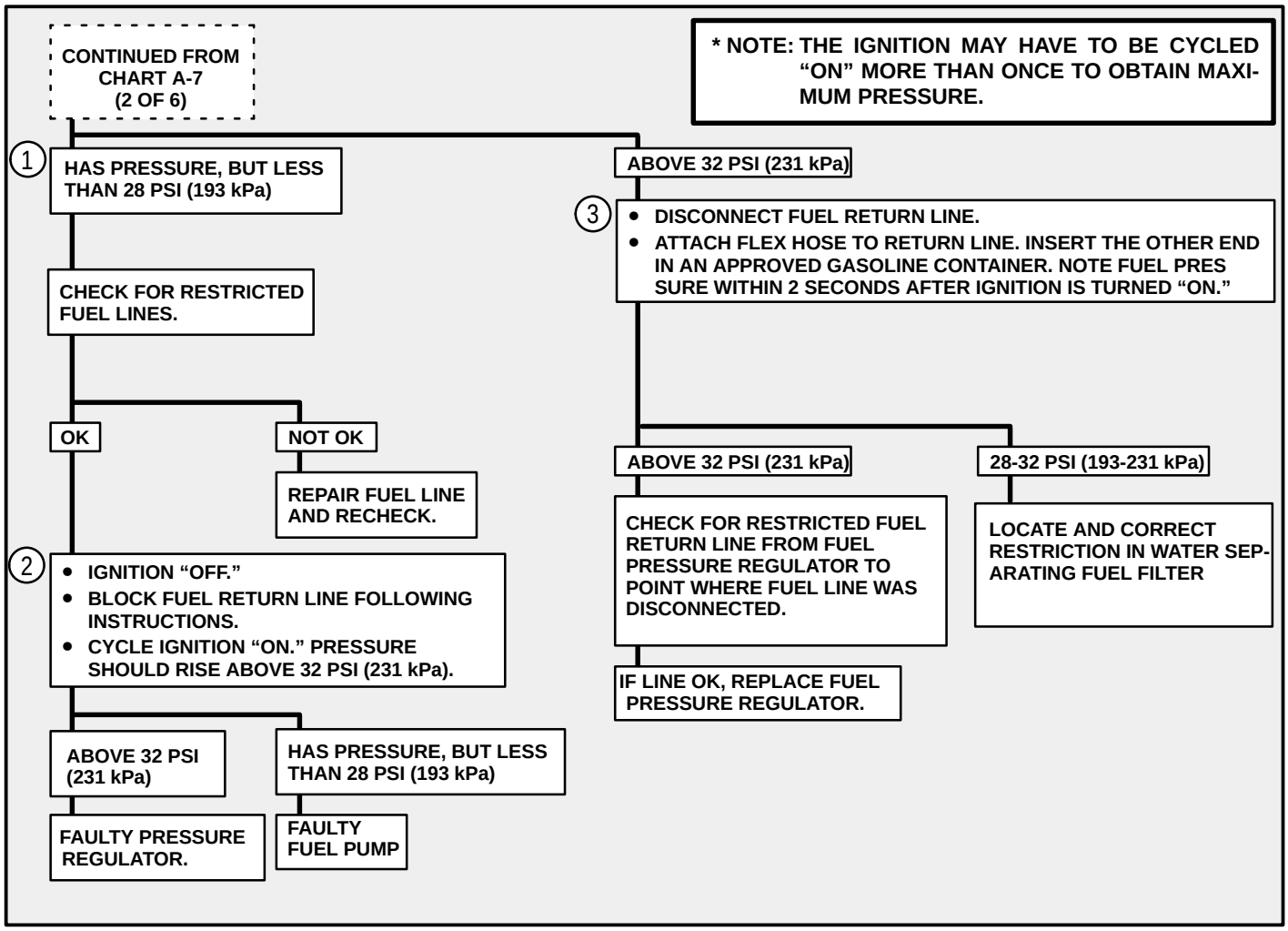
- Regulated pressure less than 28 PSI (193 kPa). The system will be running lean. Also, hard starting when cold and overall poor performance will be noticed.
- Restricted flow causing pressure drop. Normally, an engine with a fuel pressure of less than 24 PSI (165 kPa) at idle will not be driveable. However, if the pressure drop occurs only while underway, the engine will surge then stop running as pressure begins to drop rapidly. This is most likely caused by a restricted fuel line or plugged water separating fuel filter.

2. Restricting the fuel return line (Shut-Off Valve) allows the fuel pressure to build above regulated pressure. With battery voltage applied to the fuel pump, pressure should rise to 60 PSI (414 kPa) as the fuel return hose is shut off with special tool.

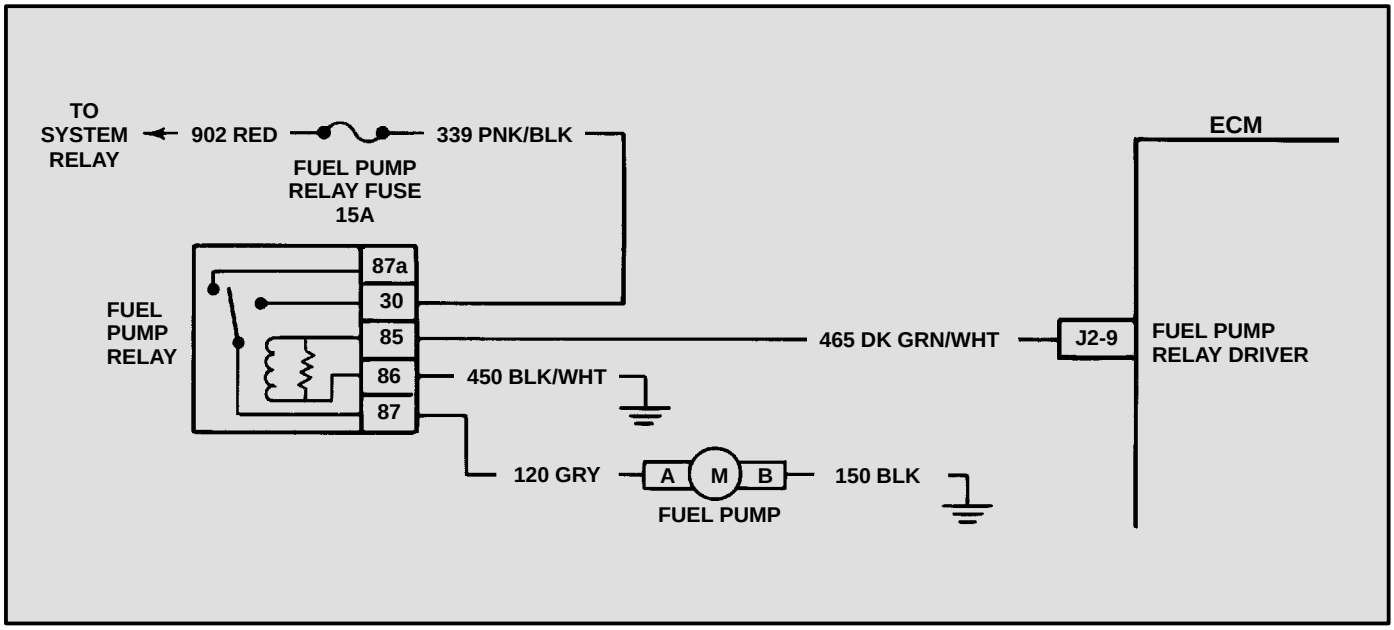
NOTE: *Do not allow fuel pressure to exceed 60 PSI (414 kPa); damage to the pressure regulator may result.*

3. This test determines if the high fuel pressure is due to a restricted fuel return line or a pressure regulator problem.

Throttle Body Injection Fuel System Diagnosis (Continued)
Chart A-7: (4 of 6)



Throttle Body Injection Fuel System Diagnosis (Continued)
Chart A-7 (5 of 6)



TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. This step checks if there is power to the fuel pump relay.
2. Bypassing the relay circuit should cause the fuel pump to run. This step should identify if the fault is in the relay or in the fuel pump circuit.
3. This step checks if there is an open in the ground circuit.
4. This step checks if the ECM is functioning properly.

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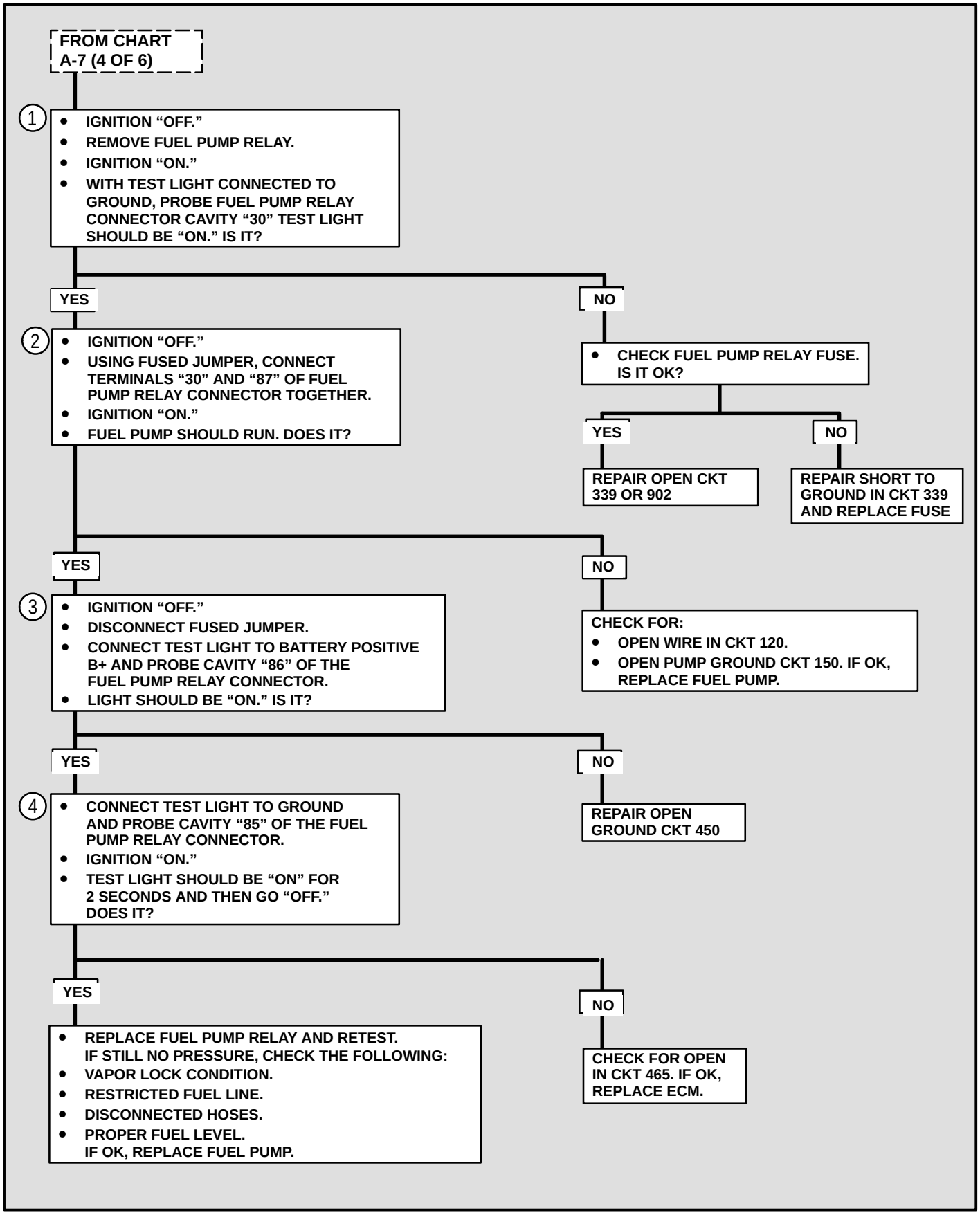
Throttle Body Injection Fuel System Diagnosis (Continued)
Chart A-7: (6 of 6)



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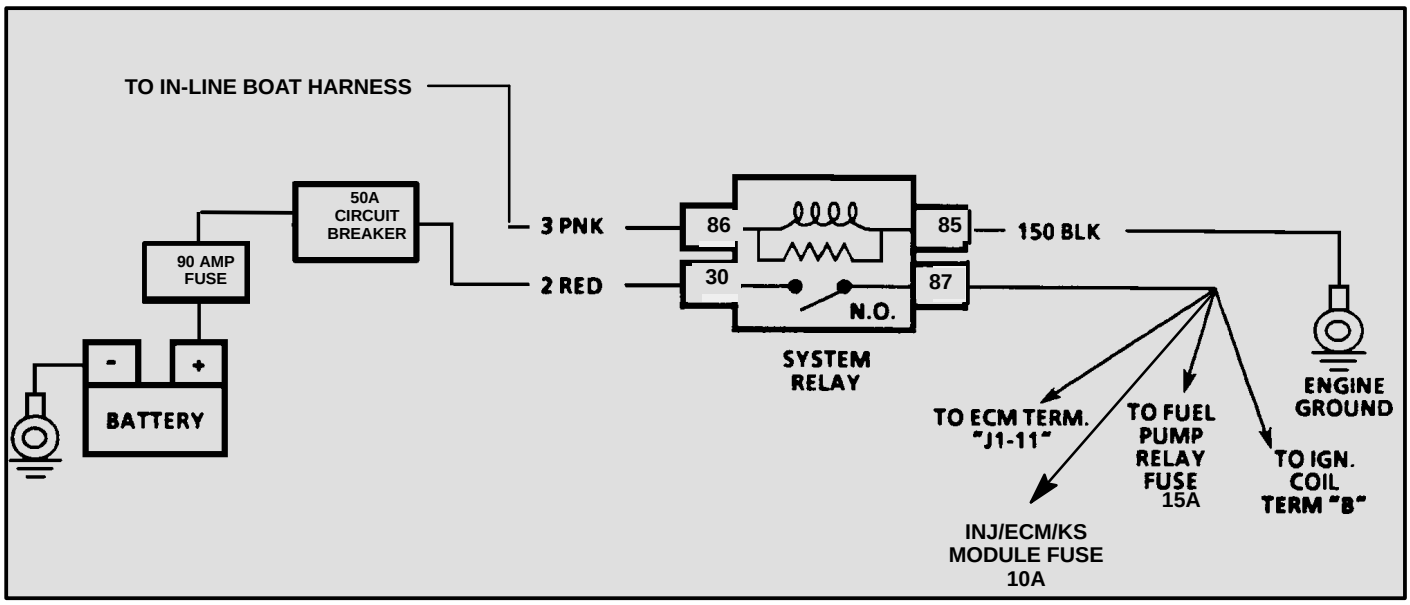
EFI System/Ignition Relay Check
(1 of 2)



CIRCUIT DESCRIPTION:

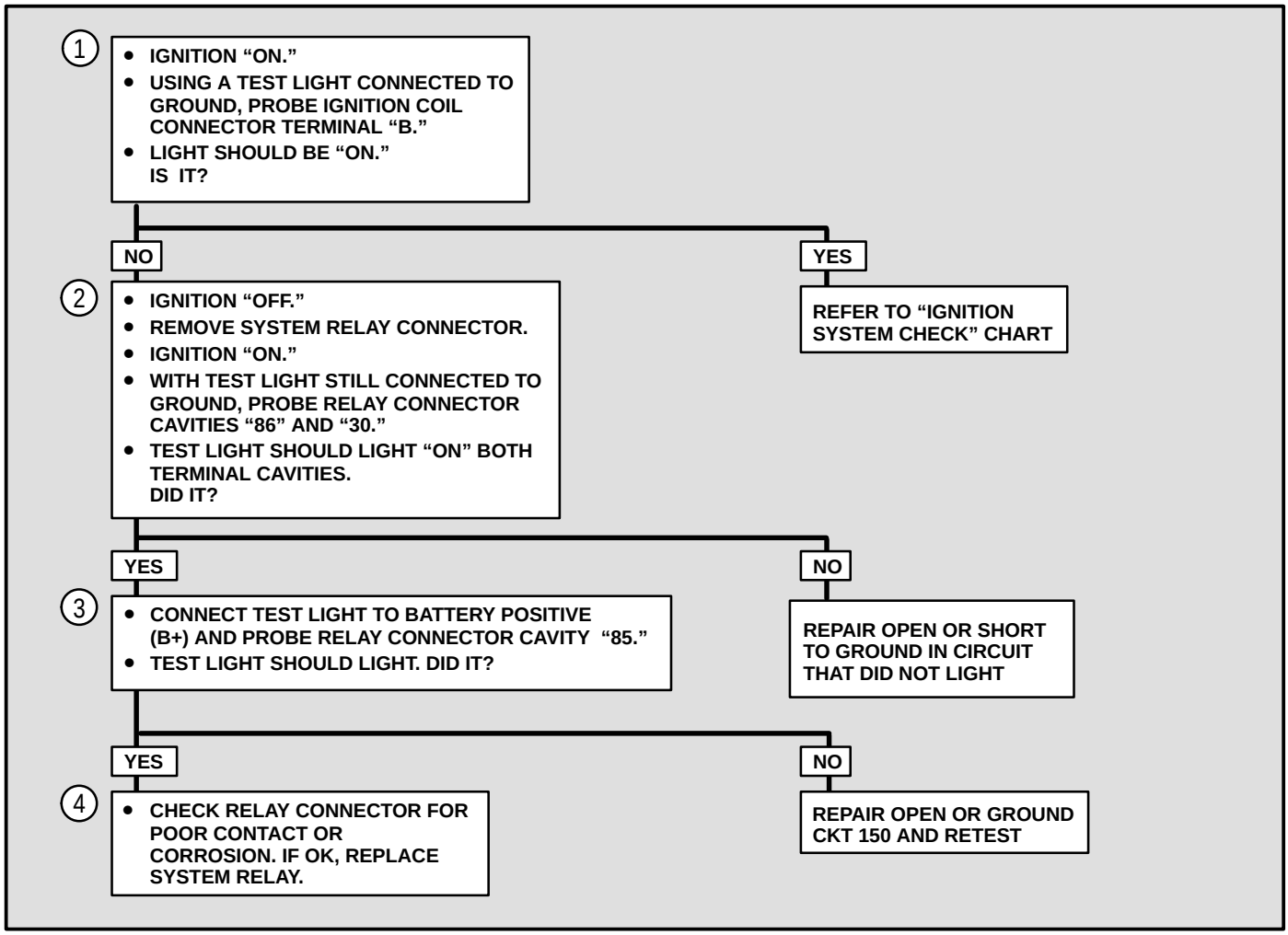
Battery voltage is constantly supplied to terminal 30 of the system relay. When the ignition switch is moved to the run position, battery voltage is supplied to terminal 86 of the system relay. The pull-in coil is then energized, creating a magnetic field which closes the contacts of the system relay. Voltage and current are then supplied to the ignition coil, injectors, ECM and fuel pump relay fuse through terminal 87 of the system relay.

TEST DESCRIPTION:

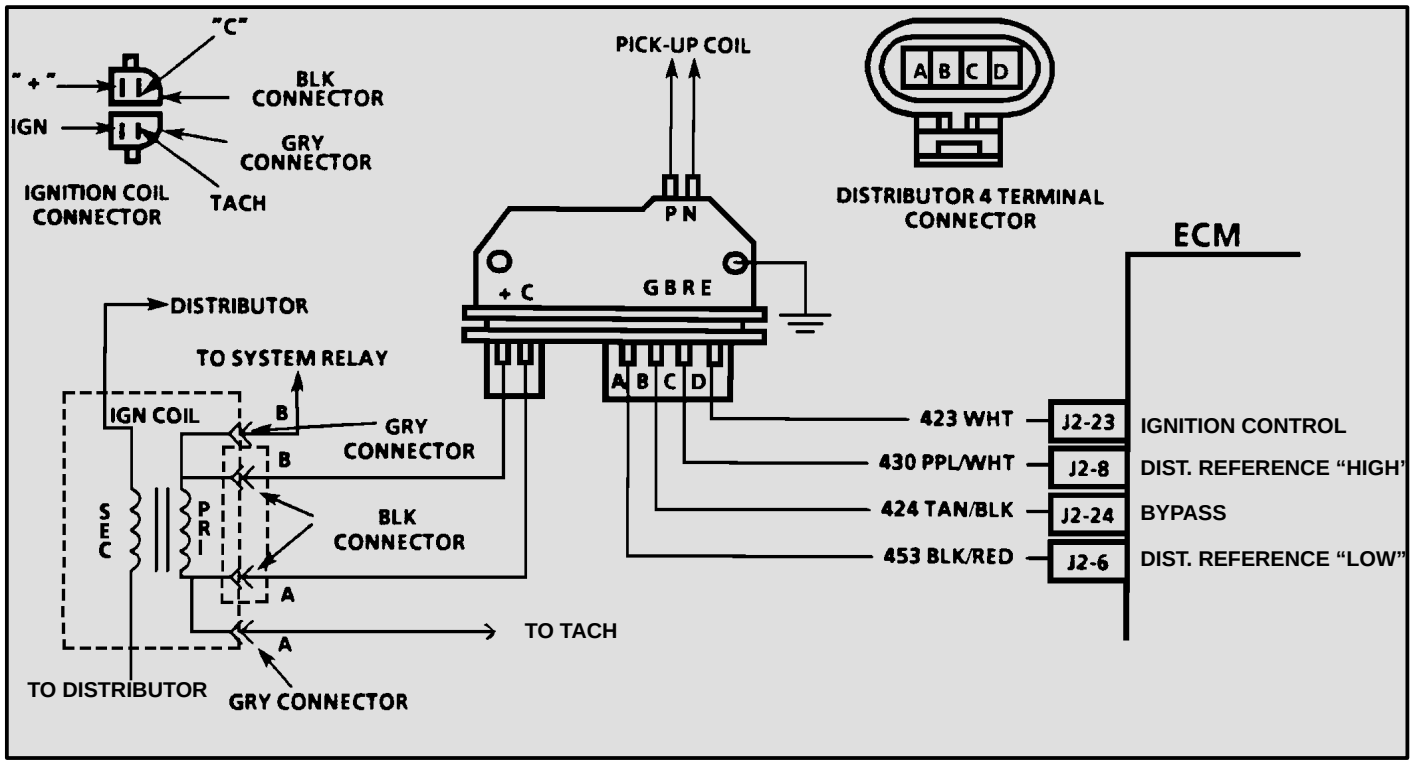
Number(s) below refer to circled number(s) on the diagnostic chart.

1. This step identifies if the relay is functioning properly. If a fault in the relay circuit were present, voltage would not be available at terminal B of the ignition coil.
2. This step ensures that battery and ignition voltage are available at the relay. An open or shorted condition in either supply would cause the relay not to operate.
3. This step ensures that a good ground exists to terminal 85 of the system relay. An open ground to this terminal would not allow current to flow through the pull-in coil.
4. At this point, the circuits leading to the relay have been checked, and a careful visual inspection of the relay terminals should be preformed prior to replacement of the system relay.

EFI System / Ignition Relay Check (Continued)
(2 of 2)



Ignition System Check
(1 of 2)



TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. Two spark plug wires are checked, to ensure that an open is not present in a spark plug wire.

   If spark occurs with Ignition Control (IC) connector disconnected, magnetic field output is too low for Ignition Control (IC) operation.

2. A spark indicates the problem must be the distributor cap or rotor.

3. Normally, there should be battery voltage at the "C" and "+" terminals. Low voltage would indicate an open or a high resistance circuit from the distributor to the coil or ignition switch. If "C" terminal voltage was low, but "+" terminal voltage is 10 volts or more, circuit from "C" terminal to ignition coil or ignition coil primary winding is open.

4. Checks for a shorted module or grounded circuit from the ignition coil to the module. The distributor module should be turned OFF, so normal voltage should be about 12 volts.

   If the module is turned ON, the voltage would be low, but above 1 volt. This could cause the ignition coil to fail from excessive heat.

   With an open ignition coil primary winding, a small amount of voltage will leak through the module from the Battery Positive (B+) to the "Tach" terminal.

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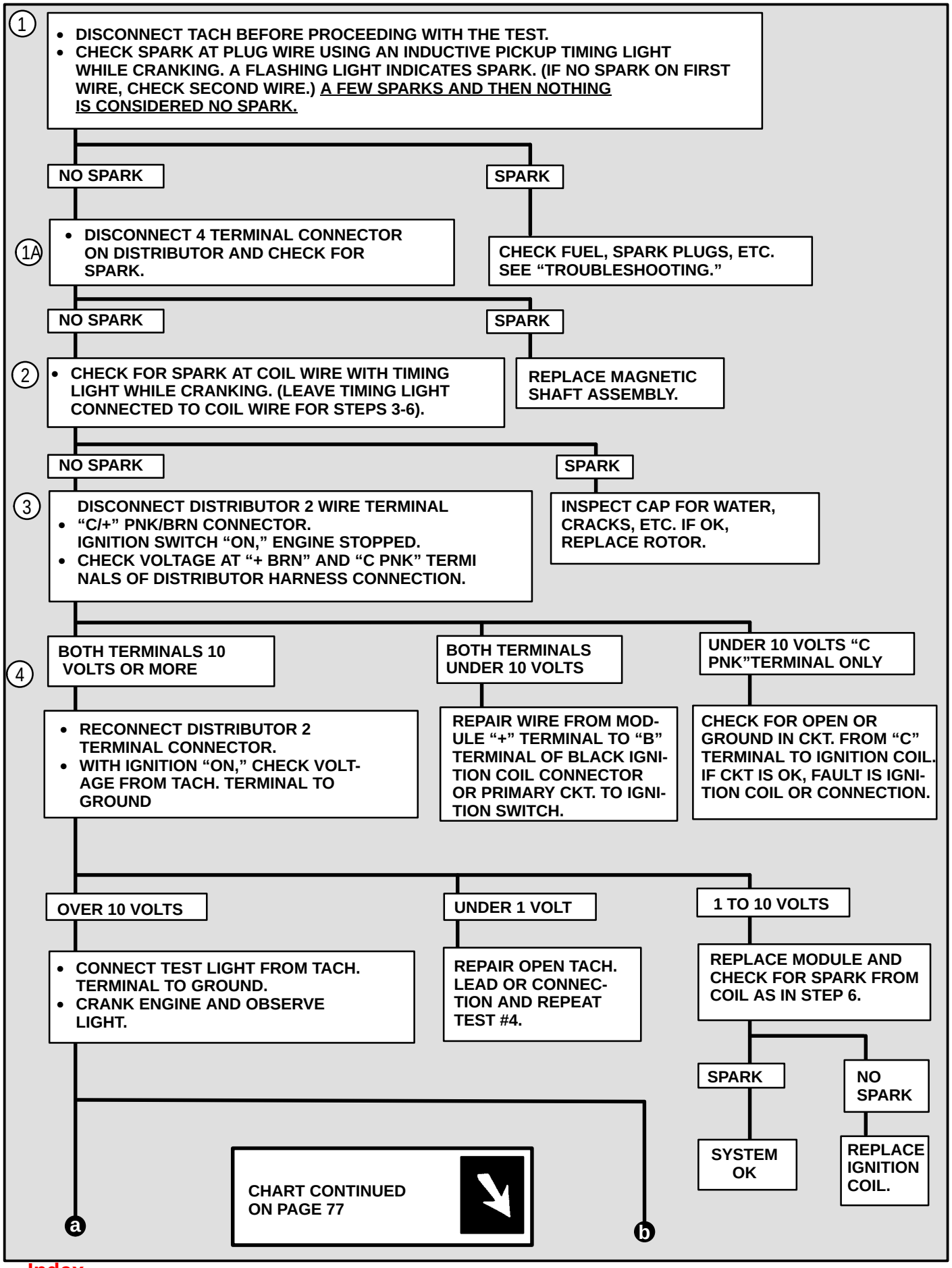
Ignition System Check(1 of 2)



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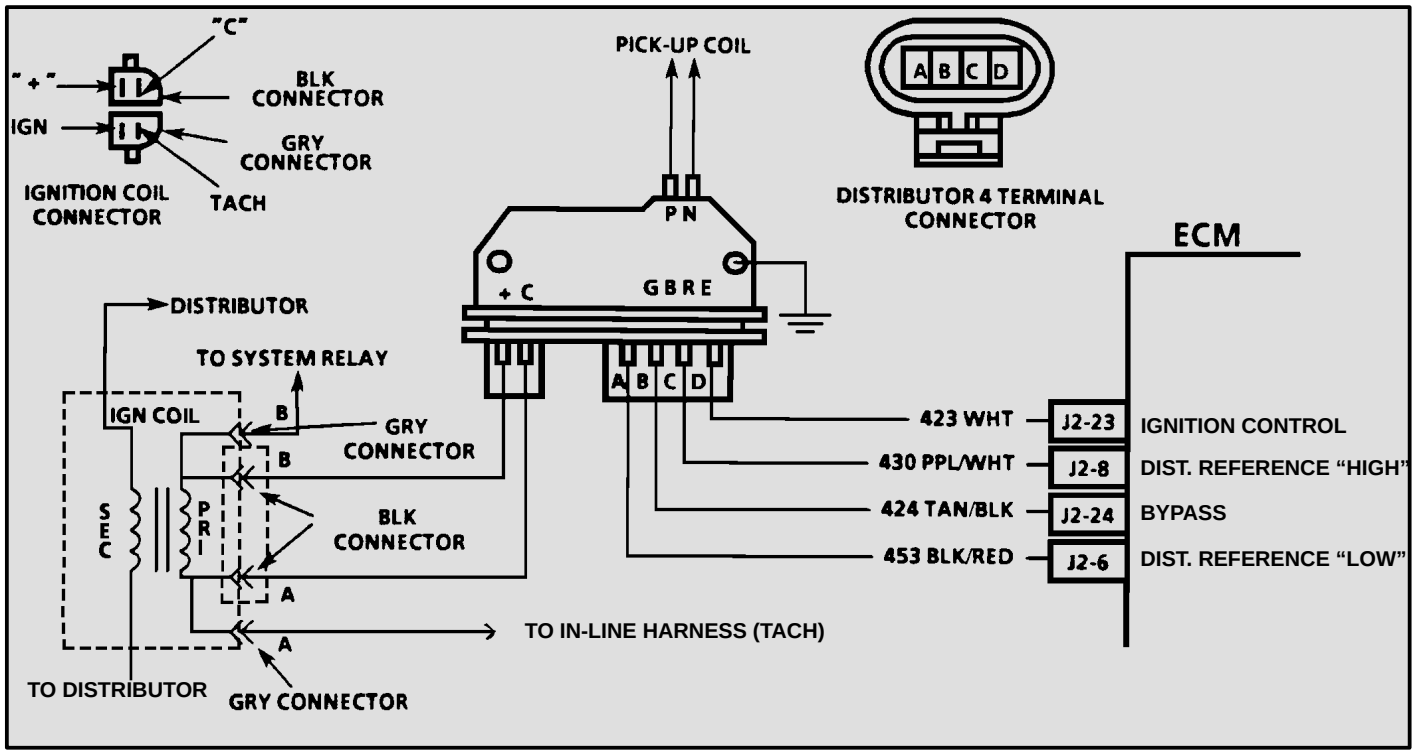
Ignition System Check
(2 of 2)



TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

5. Applying a voltage (1.5 to 8 volts) to module terminal "P" should turn the module ON and the "Tach" terminal voltage should drop to about 7-9 volts. This test will determine whether the module or coil is faulty or if the pick-up coil is not generating the proper signal to turn the module "ON." This test can be performed by using a DC battery with a rating of 1.5 to 8 volts. The use of the test light is mainly to allow the "P" terminal to be probed more easily. Some digital multimeter can also be used to trigger the module by selecting ohms, usually the diode position. In this position, the meter may have a voltage across its terminals which can be used to trigger the module. The voltage in the ohms position can be checked by using a second meter or by checking the manufacturer's specification of the tool being used.
6. This should turn OFF the module and cause a spark. If no spark occurs, the fault is most likely in the ignition coil because most module problems would have been found before this point in the procedure.

Ignition System Check (2 of 2)

CHART CONTINUED FROM PAGE 75

a

LIGHT ON STEADY

b

LIGHT BLINKS

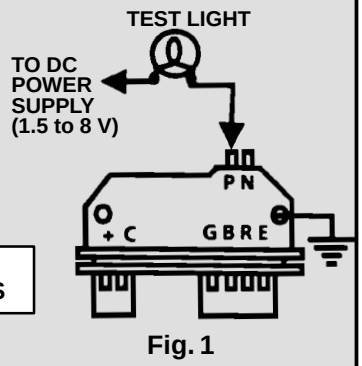


Fig. 1

5

- DISCONNECT DISTRIBUTOR 4 TERMINAL CONNECTOR.
- REMOVE DISTRIBUTOR CAP.
- DISCONNECT PICK-UP COIL CONNECTOR FROM MODULE.
- CONNECT VOLTMETER FROM TACH. TERMINAL TO GROUND.
- IGNITION "ON."
- INSULATE A TEST LIGHT PROBE TO 1/4, FROM TIP AND NOTE VOLTAGE, AS TEST LIGHT IS MOMENTARILY CONNECTED FROM A VOLTAGE SOURCE (1.5 TO 8 V) TO MODULE TERMINAL "P" (CHART 1 OF 2 PAGE 78).

REPLACE IGNITION COIL AND RECHECK FOR SPARK WITH TIMING LIGHT. IF STILL NO SPARK, REINSTALL ORIGINAL COIL AND REPLACE DISTRIBUTOR MODULE.

VOLTAGE DROPS

NO DROP IN VOLTAGE

6

- CHECK FOR SPARK FROM COIL WIRE WITH TIMING LIGHT AS TEST LIGHT IS REMOVED FROM MODULE TERMINAL

CHECK MODULE GROUND. IF OK, REPLACE MODULE.

NO SPARK

SPARK

- REPLACE IGNITION COIL AND REPEAT STEP 5.

- IS ROTATING POLE PIECE STILL MAGNETIZED?

NO SPARK

SPARK

YES

NO

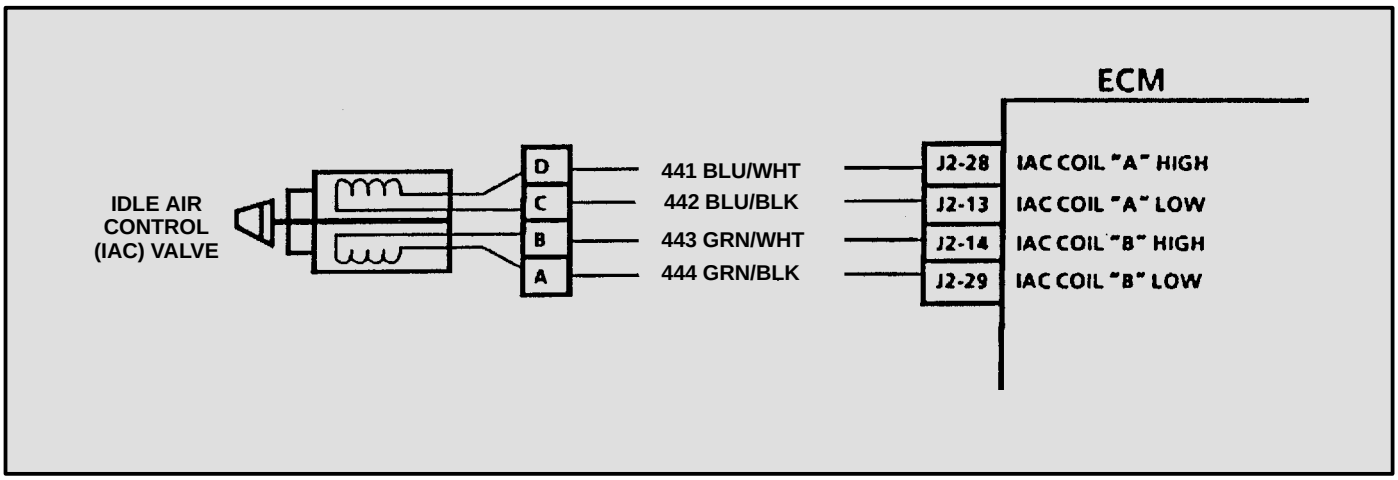
IGNITION COIL REMOVED IS OK, REINSTALL COIL AND CHECK COIL WIRE FROM DIST. CAP. IF OK, REPLACE DISTRIBUTOR MODULE.

SYSTEM OK

CHECK PICK-UP COIL OR CONNECTIONS (COIL RESISTANCE SHOULD BE 500-1500 OHMS AND NOT GROUNDED.)

REPLACE POLE PIECE AND SHAFT ASSEMBLY.

Idle Air Control (IAC) Functional Test
(1 of 2)



CIRCUIT DESCRIPTION:

The ECM controls idle speed to a calculated, "desired" RPM based on sensor inputs and actual engine RPM, determined by the time between successive ignition reference pulses from the ignition module. The ECM uses four circuits to move an Idle Air Control (IAC) valve, which allows varying amounts of air flow into the intake manifold, controlling idle speed.

IMPORTANT: Improper IAC readings or improper idle speed can result from other faults ie: flooding VST, fouled spark plugs, bad sensors. These items should be in proper working order to ensure correct diagnosis.

TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the functional check chart.

1. This step determines if the IAC valve is functioning properly.
2. This step determines if the circuitry or the IAC valve is faulty.

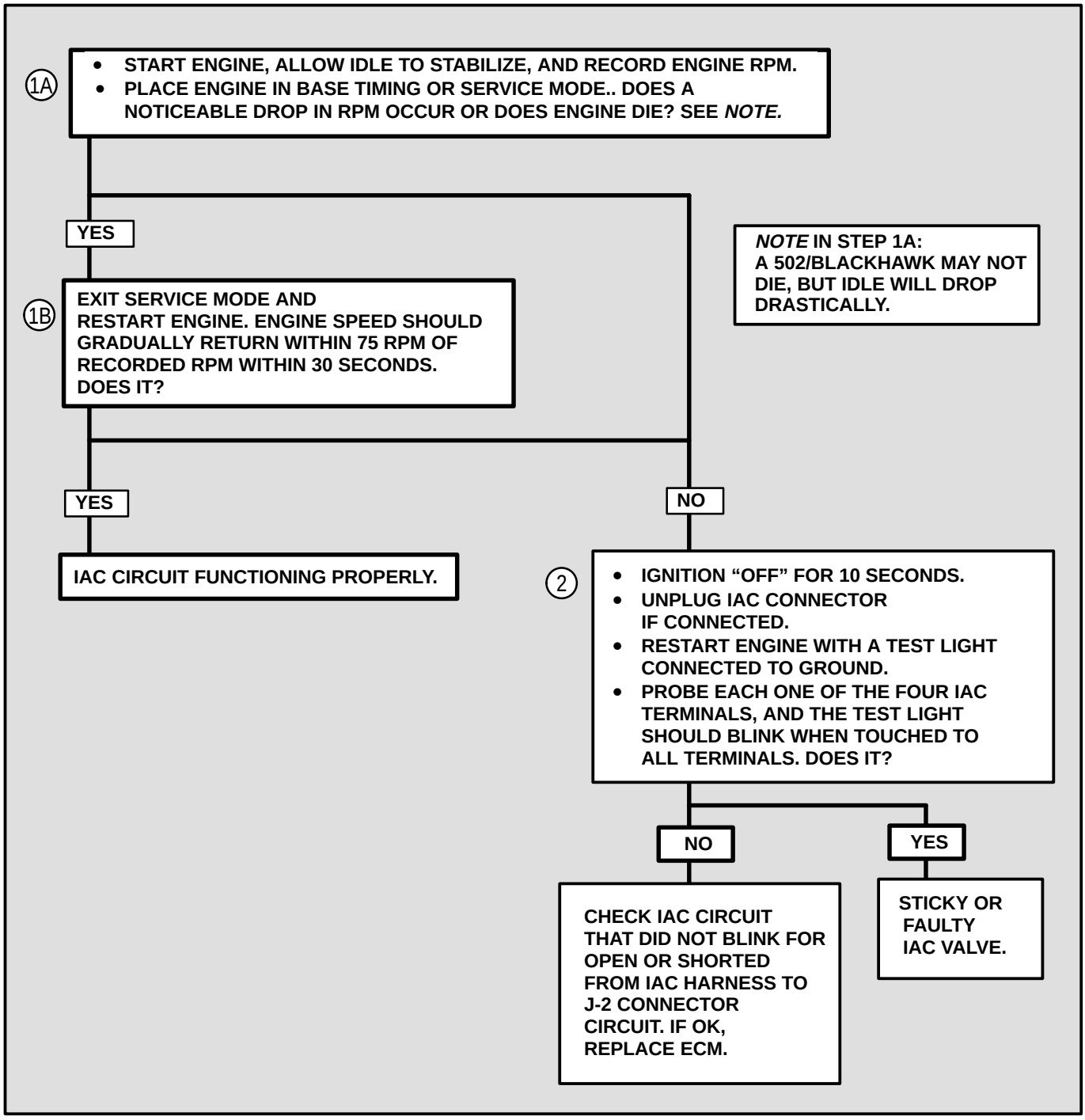
DIAGNOSTIC AIDS:

Check for vacuum leaks, unconnected or brittle vacuum hoses, cuts, etc. Examine manifold and throttle body gaskets for proper seal. Check for cracked intake manifold/plenum. Check open, shorts, or poor connections to IAC valve in CKTs 441, 442, 443 and 444.

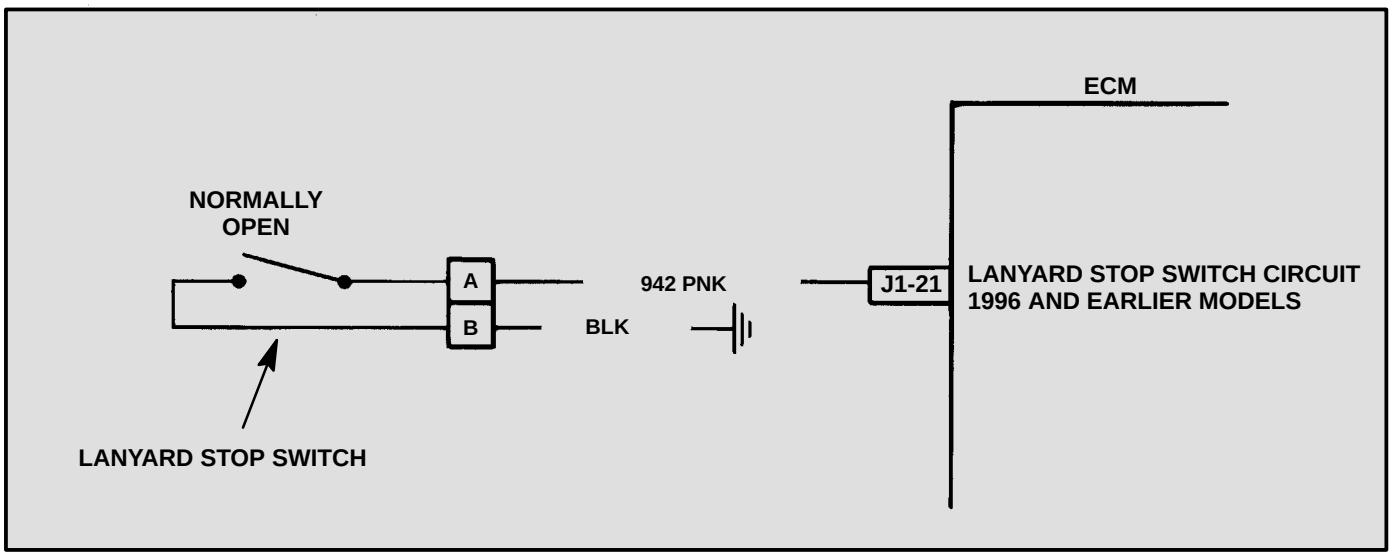
An open, short, or poor connection in CKTs 441, 442, 443, or 444 will result in improper idle control and may cause improper idle.

An IAC valve which is stopped and cannot respond to the ECM, a throttle stop screw which has been tampered with, or a damaged throttle body or linkage could cause improper idle.

Idle Air Control Functional Test
(2 of 2)



Lanyard Stop Circuit Check (Emergency Stop) Circuit Check (1 of 2)



NOTE: *Some models are no longer equipped with this option in the wiring harness. Connection of the lanyard stop switch (if equipped) is performed at the instrument panel.*

CIRCUIT DESCRIPTION:

The Lanyard Stop circuit is a safety feature incorporated in boats to stop the engine in the event that the operator is removed from a safe control position during normal operation. The Lanyard Stop switch is a normally open switch that is physically connected to the operator by a tether. In the event that the operator is removed from a control position, the tether connected to the switch will be pulled out, closing the switch. This information from the Lanyard Stop switch will then be used by the ECM to cease engine operation until the position of the switch is restored to its normally open position and the ignition key switch has been cycled.

TEST DESCRIPTION:

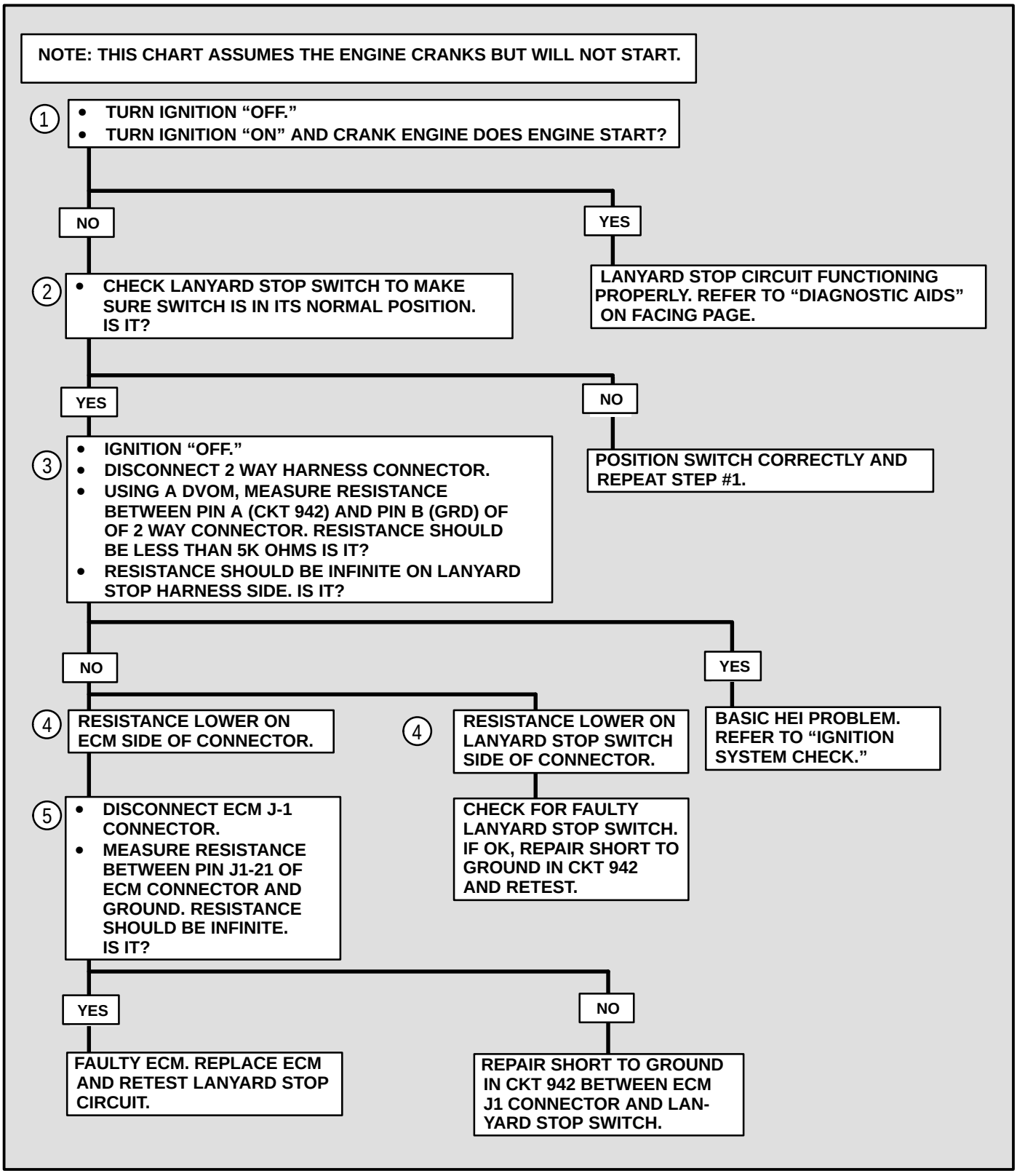
1. If a Lanyard Stop was recognized by the ECM, cycling the ignition will clear the Lanyard Stop condition in the ECM.
2. This step checks to see if the Lanyard Stop switch is in the correct position. If the switch is closed, a Lanyard Stop condition will exist.
3. This step checks for Lanyard Stop switch or Lanyard Stop circuitry that is shorted to ground.
4. This step identifies which half of the circuitry is shorted to ground; i.e., ECM side or switch side.
5. This step identifies if the circuitry or ECM is the cause of the short to ground.

DIAGNOSTIC AIDS:

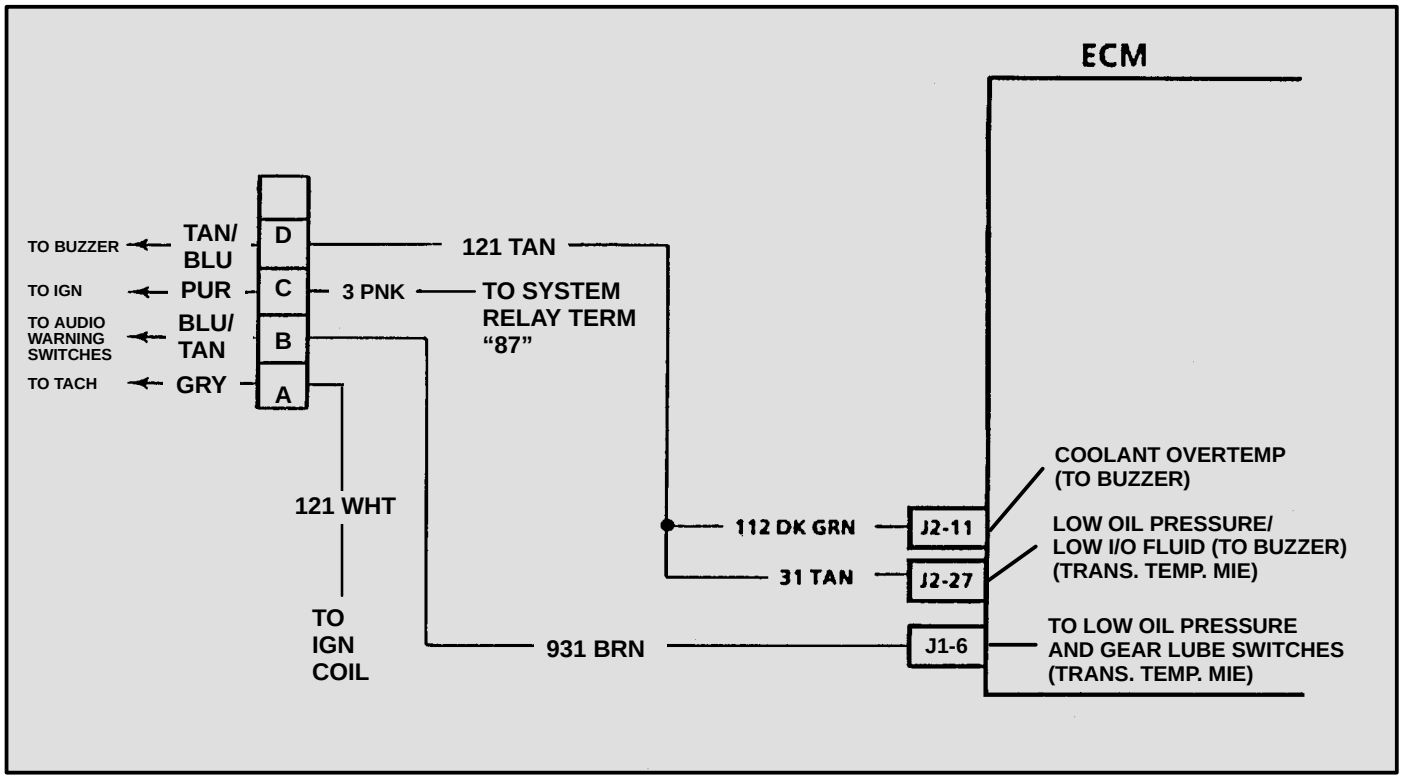
An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry that is suspected as causing the intermittent complaint should be thoroughly checked for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness.

Lanyard Stop (Emergency Stop) Circuit Check (2 of 2)



Audio Warning Buzzer Circuit Check
(1 of 2)



CIRCUIT DESCRIPTION:

The audio warning buzzer function of the ECM is used to alert the operator of a critical engine function parameter. Used in conjunction with the discrete input circuitry, the ECM will supply ignition current to activate the buzzer if a change of state is indicated by any of the discrete inputs. When a discrete switch changes state from normally open to closed, the ECM interprets that an anomaly is present and will complete the ground to the affected buzzer circuit, energizing the buzzer.

TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the functional check chart.

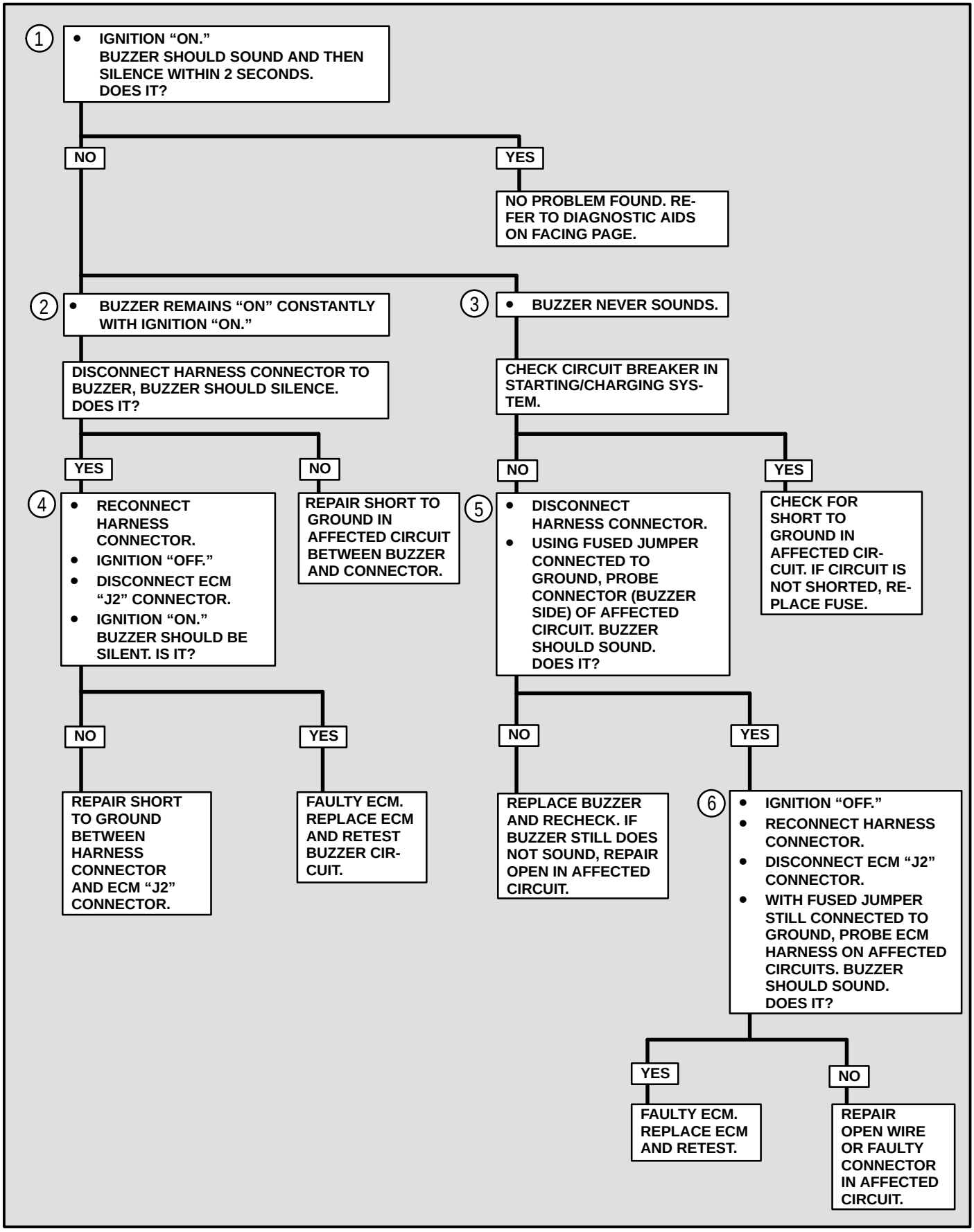
1. This step performs a functional check of the buzzer circuit.
2. This step identifies a short to ground in the control circuit.
3. This step identifies an open in the control circuit.
4. This step identifies if the fault is a short in the harness or a faulty ECM.
5. This step checks for an open in the circuitry from the harness connector to the ignition fuse.
6. This step identifies if the open circuit is due to a faulty ECM or warning buzzer circuitry.

DIAGNOSTIC AIDS:

An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry that is suspected as causing the intermittent complaint should be thoroughly checked for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness.

Audio Warning Buzzer Circuit Check (2 of 2)



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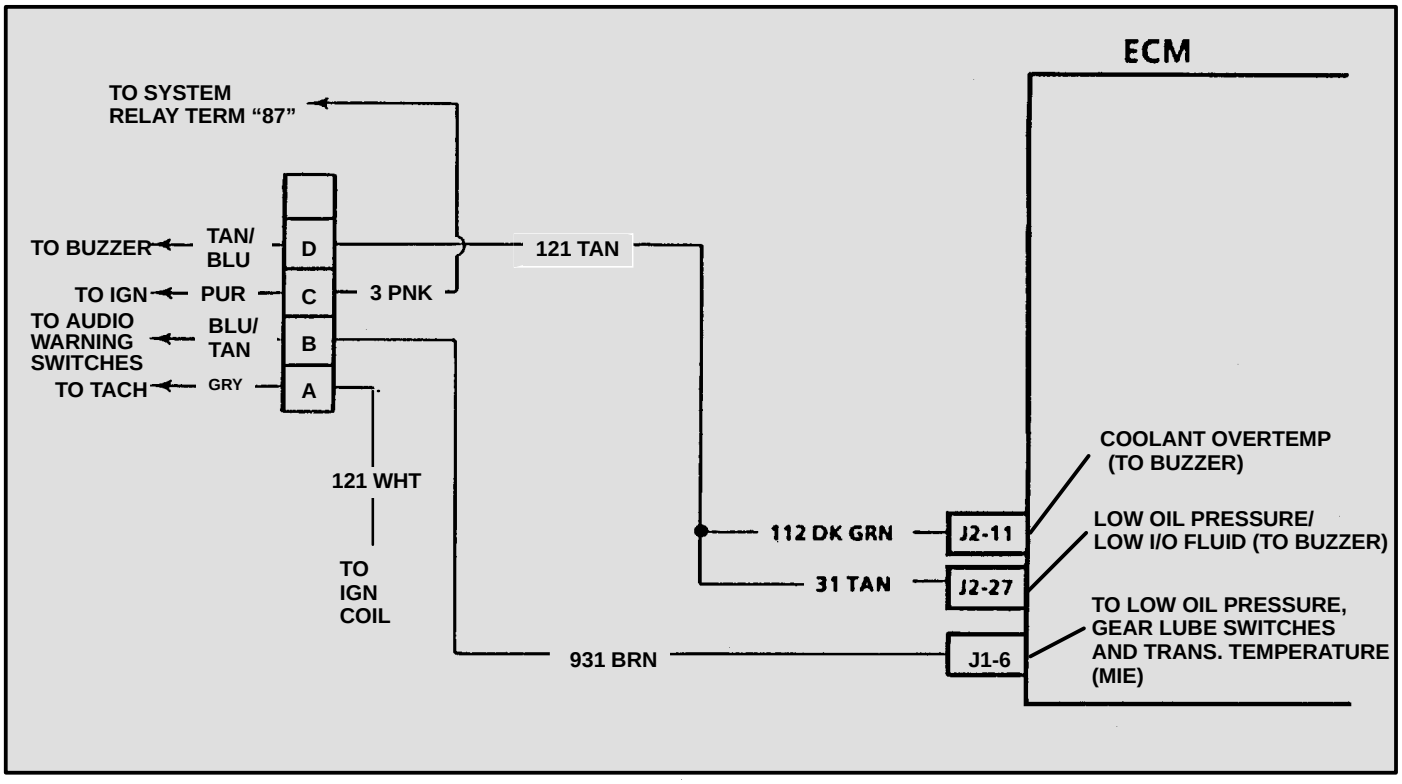
Discrete Input Circuit Check (Power Reduction Mode) (Non-Scan) (1 of 2)



CIRCUIT DESCRIPTION:

Several discrete switch inputs are utilized by the fuel injection system to identify abnormal conditions that may affect engine operation. A pull-up switch is currently used in conjunction with the ECM to detect critical conditions to engine operation.

If a switch changes states from its normal at-rest position, that is normally open to closed, the ECM senses a change in voltage and responds by entering power reduction mode. (And activating the audio warning system.)

NOTE: *Power reduction mode is not used 1997 and later models.*

This engine protection feature allows the driver full engine power up to 2800 RPM, but disables four fuel injectors above 2800 RPM until the engine RPM drops to 1200 RPM.

This feature allows the operator a comfortable maneuvering speed while removing the possibility of high RPM engine operation until the problem is corrected.

TEST DESCRIPTION:

NOTE:Refer to Section 4C to test transmission temperature switch.

1. This step checks if wiring from the engine switches to the ECM is not shorted to ground.
2. This step ensures that the discrete switches are functioning properly by changing state.(I/O oil level, transmission temperature will not change state.)

DIAGNOSTIC AIDS:

- Check engine oil and I/O fluid levels, transmission fluid, overheat.
- If above diagnostics are performed and no change in performance is made, refer to "Troubleshooting."

An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, or a wire that is broken inside the insulation.

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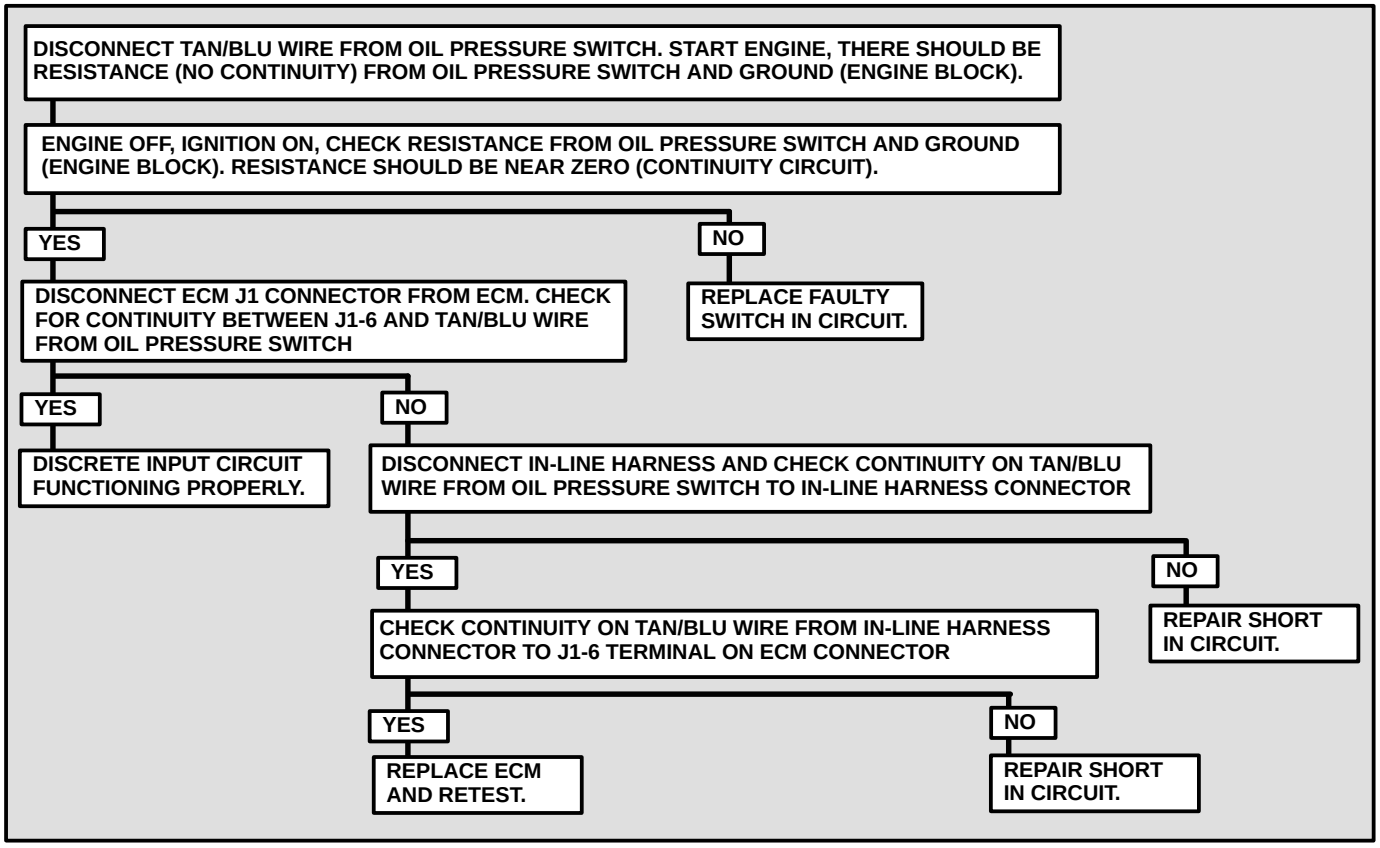
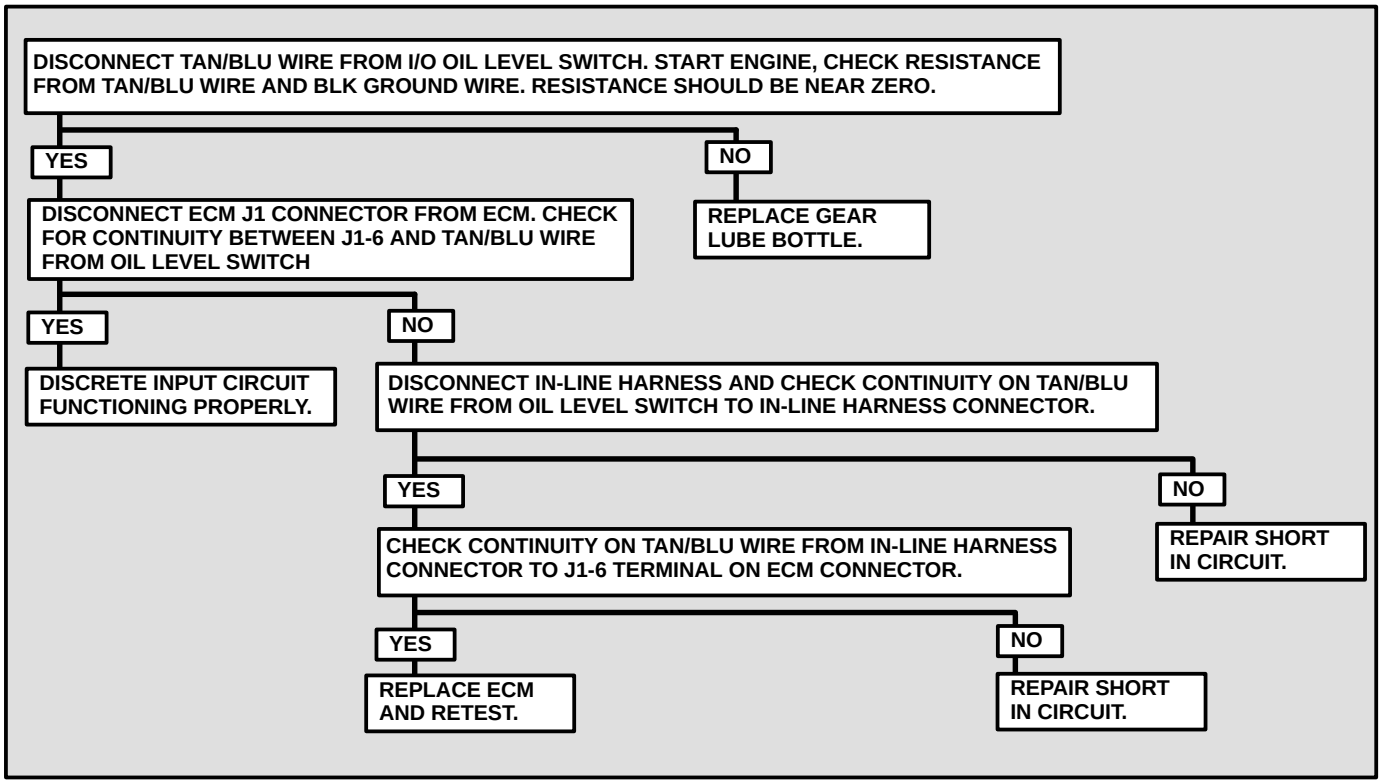
Discrete Input Circuit Check
(2 of 2)

OIL PRESSURE SWITCH



I/O LEVEL SWITCH (GEAR LUBE MONITOR)



REFER TO REPAIR PORTION OF THIS SECTION FOR TESTING OF TRANSMISSION FLUID TEMPERATURE SWITCH.

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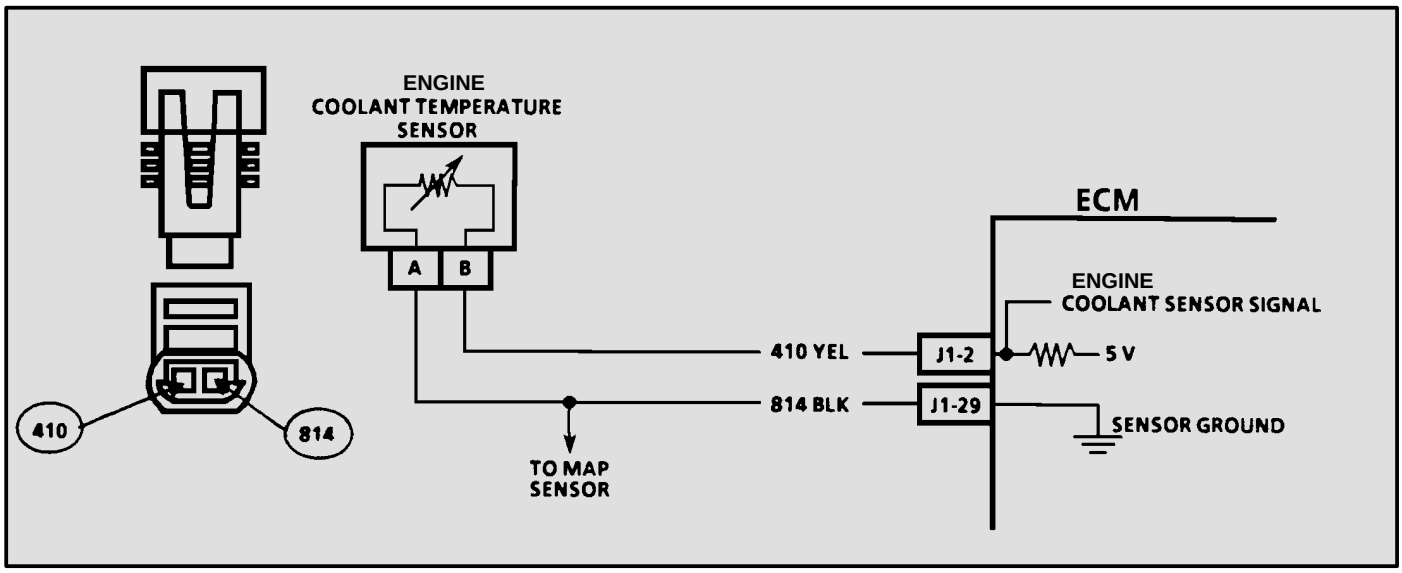
Diagnostics-Without Scan Tool

Code 14: Engine Coolant Temperature (ECT) Sensor Circuit (Non-Scan) (1 of 2)



CIRCUIT DESCRIPTION:

The Engine Coolant Temperature (ECT) sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies a voltage on CKT 410 to the sensor. When the engine coolant is cold, the sensor (thermistor) resistance is high; therefore, the ECM will see high signal voltage.

As the engine coolant warms, the sensor resistance becomes less, and the voltage drops.

TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. This step checks if there is a problem with the ECM and wiring or if the problem is the coolant sensor.
2. Check the harness terminals thoroughly for loose connection. If the resistance or the coolant sensor is monitored, the resistance should steadily decrease as the engine coolant warms up. The resistance reading would stabilize when the thermostat opens.
3. This step will isolate the problem to CKT 410 (5 volt reference) or to the sensor ground.
4. This step identifies if CKT 410 is open or shorted to ground.

DIAGNOSTIC AIDS:

An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry that is suspected as causing the intermittent complaint should be thoroughly checked for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, clear codes following “Clearing Codes” in “ECM Self-Diagnostics.” Failure to do so may result in codes not properly being cleared. Check harness routing for a potential short to ground in CKT 410. See “Intermittents” in “Troubleshooting.”

IMPORTANT: If replacing the ECT, tighten hand tight plus 2-1/2 turns maximum.

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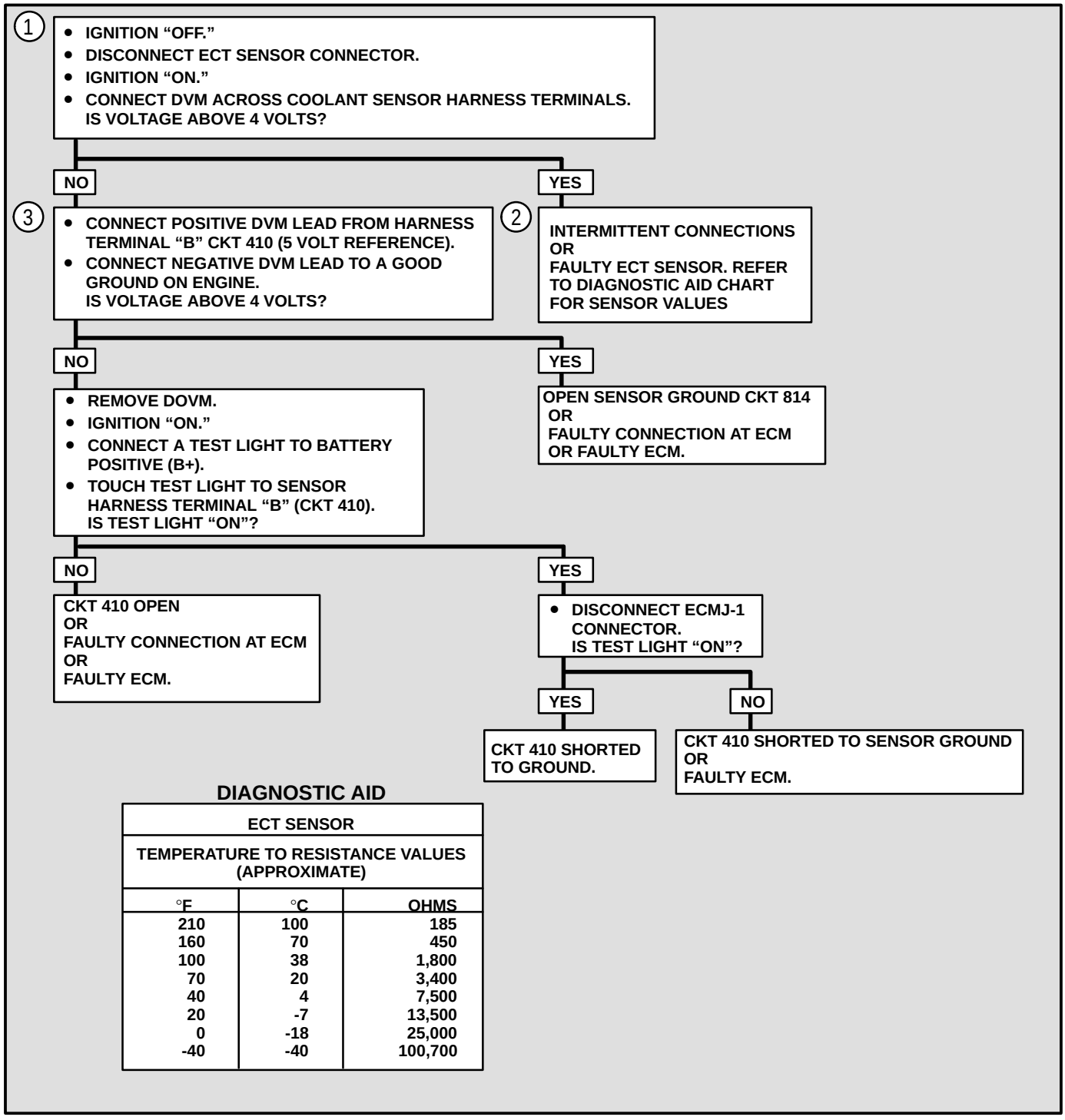
Code 14: ECT Circuit (Non-Scan)
(2 of 2)



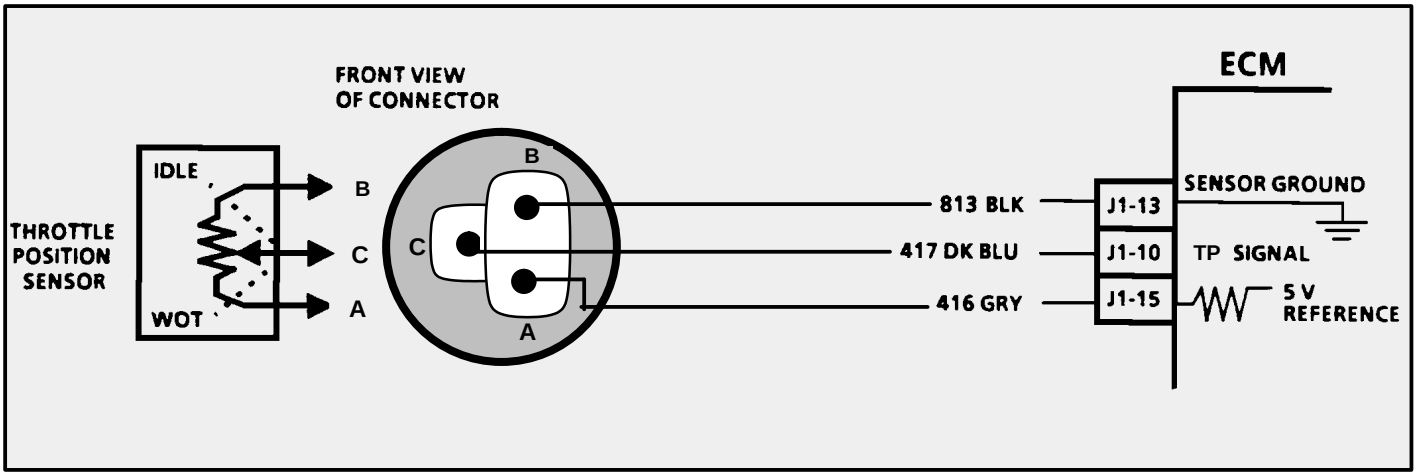
DIAGNOSTIC AID

ECT SENSOR

TEMPERATURE TO RESISTANCE VALUES (APPROXIMATE)

°F	°C	OHMS
210	100	185
160	70	450
100	38	1,800
70	20	3,400
40	4	7,500
20	-7	13,500
0	-18	25,000
-40	-40	100,700

Code 21: Throttle Position (TP) Sensor Circuit (Non-Scan) (1 Of 2)



CIRCUIT DESCRIPTION:

The Throttle Position (TP) sensor provides a voltage signal that changes, relative to the throttle blade. Signal voltage should vary from about .7 volts at idle to about 4.5 volts at Wide Open Throttle (W.O.T.).

TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

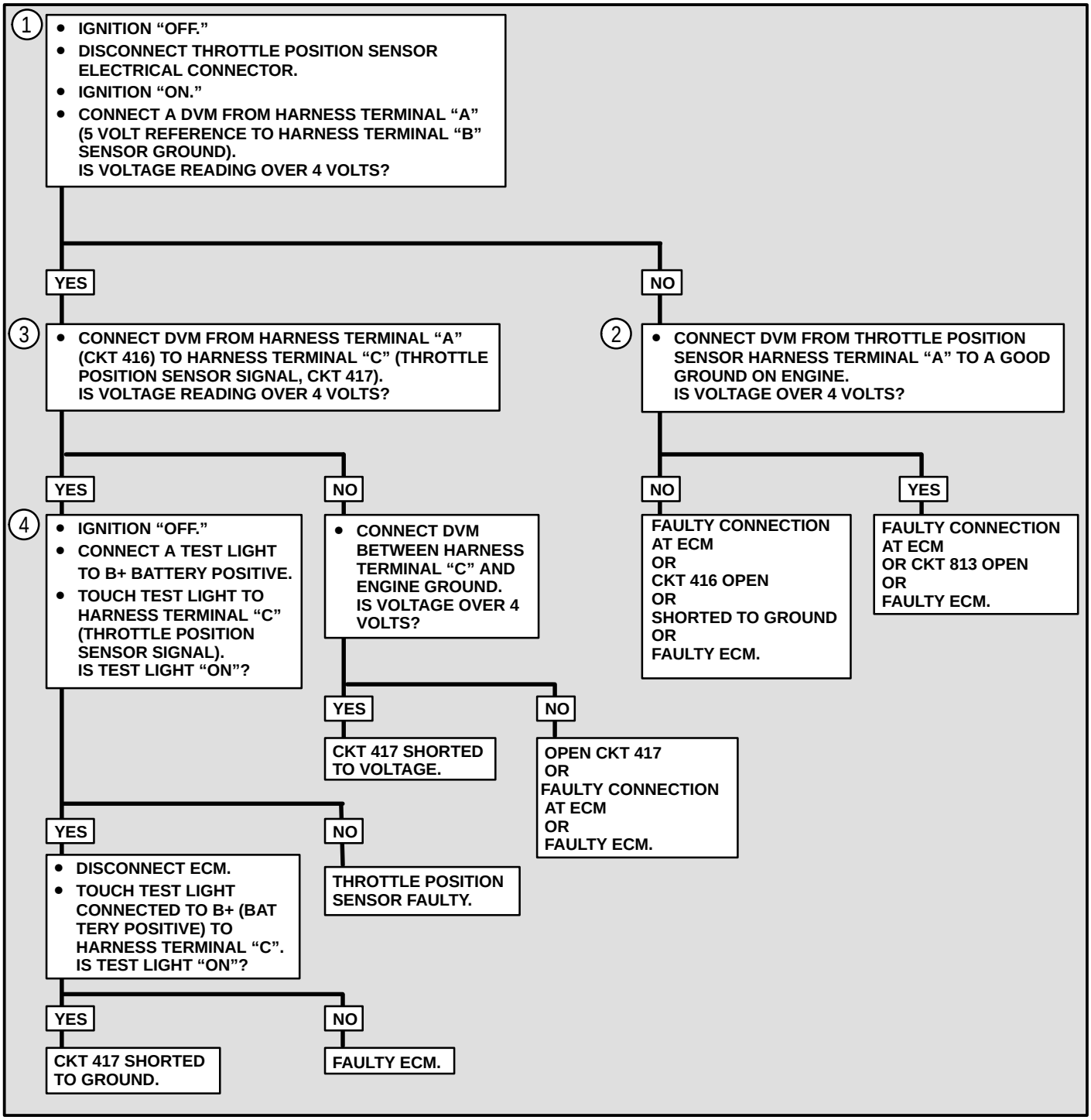
1. This step checks for a voltage from terminal “C” (5 volt reference) to terminal “A” (sensor ground).
2. This step will identify if the problem is in the supply or ground circuit.
3. This step determines if the TP sensor signal circuit to the ECM is open.
4. This step completes the test for the ECM and wiring. If the test light is not ON, the TP sensor has an internal problem.

DIAGNOSTIC AIDS:

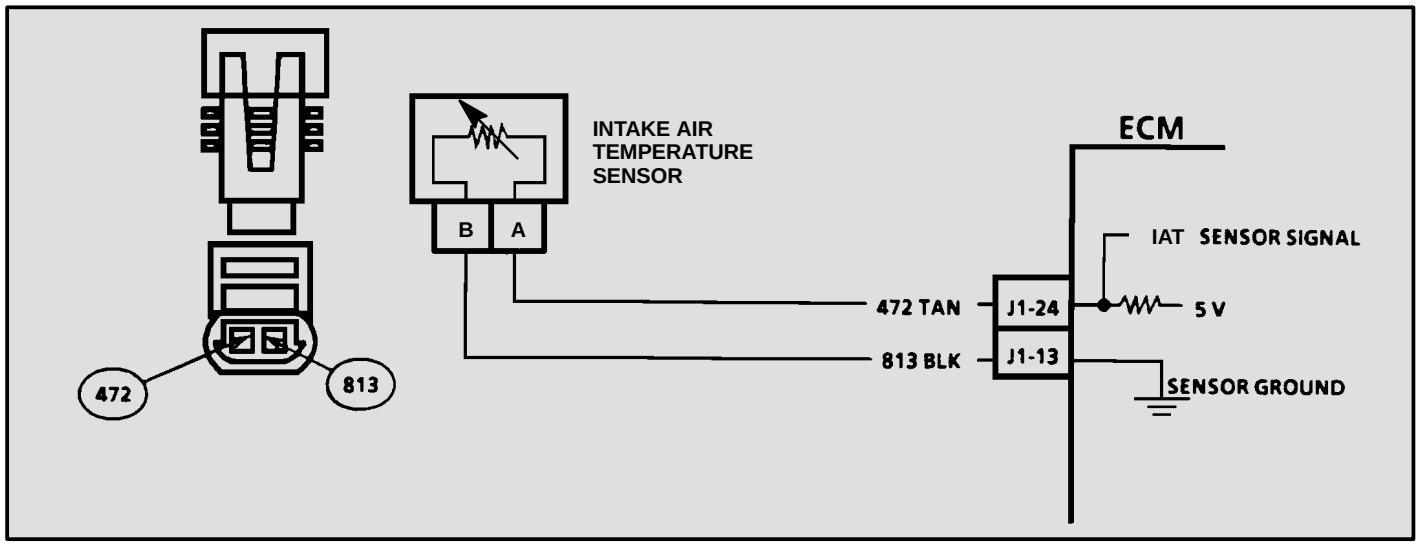
An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry that is suspected as causing the intermittent complaint should be thoroughly checked for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, clear codes following “Clearing Codes” in “ECM Self-Diagnostics.” Failure to do so may result in codes not properly being cleared. If Code 23 is also set, check CKT 813 for faulty wiring or connections. Check terminals at sensor for good contact.

Code 21: Throttle Position (TP) Sensor Circuit (Non Scan)



Code 23: Intake Air Temperature (IAT) Sensor Circuit (Non-Scan) (1 Of 2)



CIRCUIT DESCRIPTION:

The Intake Air Temperature (IAT) sensor uses a thermistor to control the signal voltage to the Electronic Control Module (ECM). The ECM applies a voltage (about 5 volts) on CKT 472 to the sensor. When the air is cold, the sensor (thermistor) resistance is high; therefore, the ECM will see a high signal voltage. If the air is warm, the sensor resistance is low; therefore, the ECM will see a low voltage.

TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. A Code 23 will set due to an open sensor, wire, or connection. This step will determine if the wiring and ECM are OK.
2. If the resistance is greater than 25,000 ohms, replace the sensor.

DIAGNOSTIC AIDS:

An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry that is suspected as causing the intermittent complaint should be thoroughly checked for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, clear codes following “Clearing Codes” in “ECM Self-Diagnostics.” Failure to do so may result in codes not properly being cleared. If Code 21 is also set, check CKT 813 for faulty wiring or connections. Check terminals at sensor for good contact.

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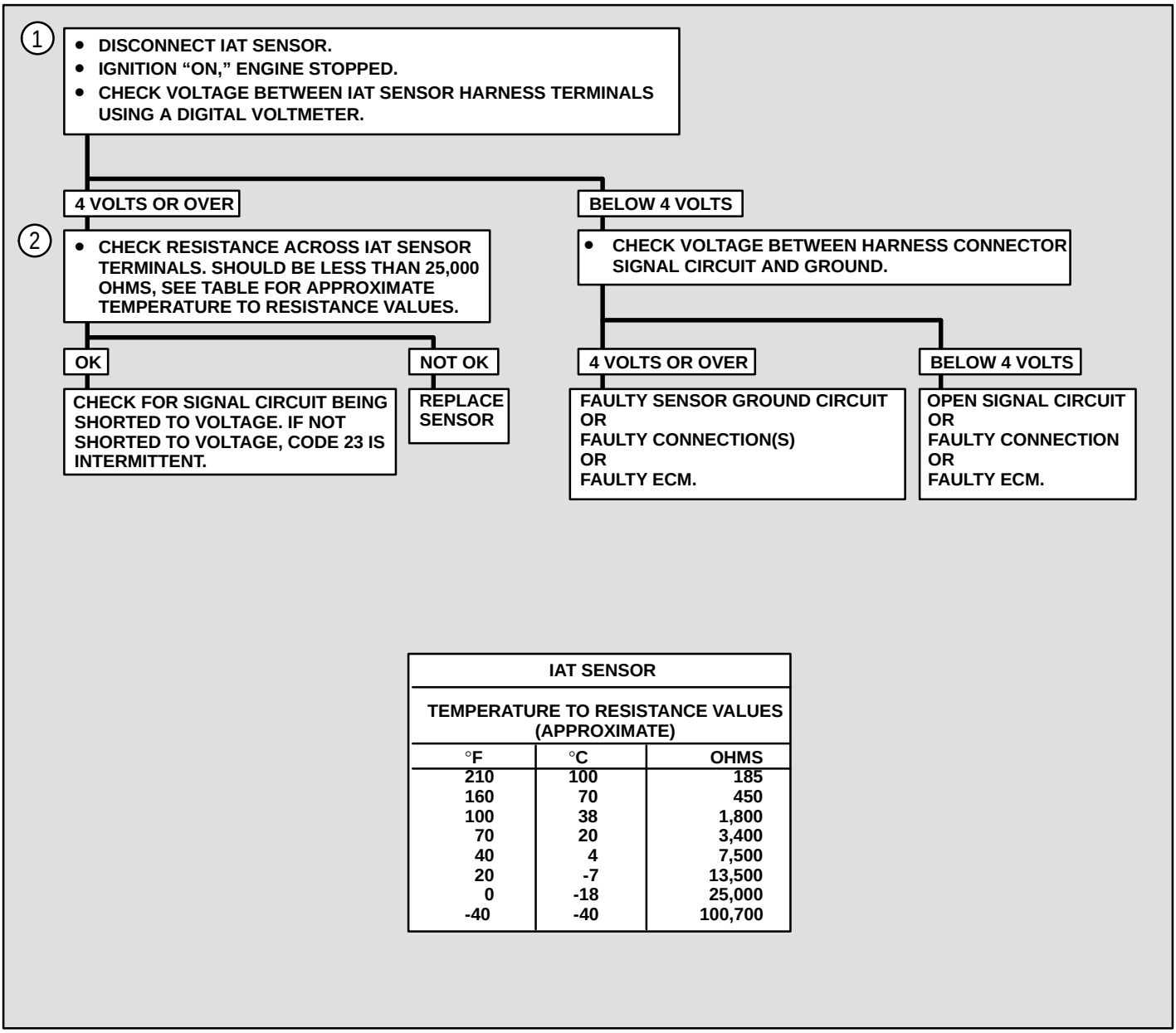
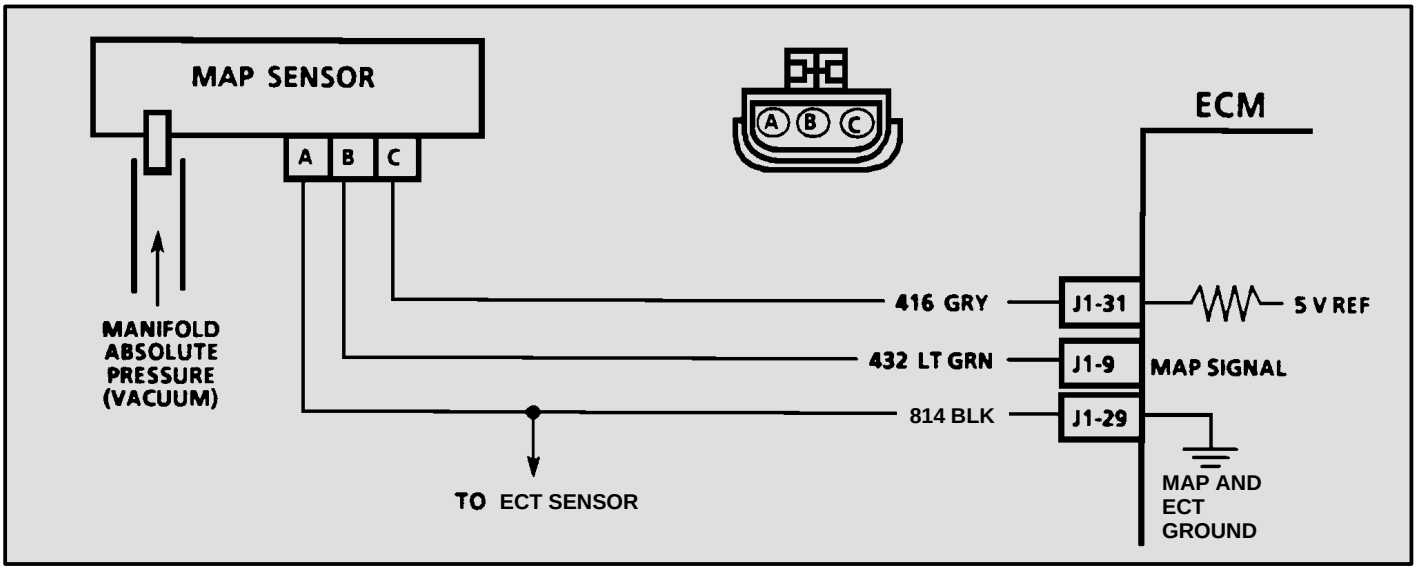
Code 23: Intake Air Temperature (IAT) Sensor Circuit (Non-Scan) (1 of 2)



IAT SENSOR		
TEMPERATURE TO RESISTANCE VALUES (APPROXIMATE)		
°F	°C	OHMS
210	100	185
160	70	450
100	38	1,800
70	20	3,400
40	4	7,500
20	-7	13,500
0	-18	25,000
-40	-40	100,700

Code 33: Manifold Absolute Pressure (MAP) Sensor Circuit (Non-Scan) (1 Of 2)



CIRCUIT DESCRIPTION:

The Manifold Absolute Pressure (MAP) sensor responds to changes in manifold pressure (vacuum). The ECM receives this information as a signal voltage that will vary from about 1-1.5 volts at closed throttle idle, to 4-4.8 volts at Wide Open Throttle (W.O.T.) (low vacuum).

If the MAP sensor fails, the ECM will substitute a fixed MAP value and use the engine RPM to control fuel delivery.

TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. This step will determine if there is an adequate vacuum supply to the MAP sensor. If the gauge reading is erratic, refer to “Stalling, Rough, Unstable or Incorrect Idle” in “Troubleshooting.”
2. Low manifold vacuum may result from vacuum leaks in the engine induction system.
3. This step checks for a voltage from terminal “C” (5 volt reference) to terminal “A” (sensor ground).
4. This step will identify if the problem is in the supply 5 V reference or ground circuit.
5. This step determines if the MAP signal circuit to the ECM is open.
6. This step completes the test for the ECM and wiring. If the test light is not ON, the MAP sensor has an internal problem. To confirm an internal MAP sensor problem, use the MAP output voltage check chart.

DIAGNOSTIC AIDS:

An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry that is suspected as causing the intermittent complaint should be thoroughly checked for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, clear codes following “Clearing Codes” in “ECM Self-Diagnostics.” Failure to do so may result in codes not properly being cleared. If Code 14 is also set, check for open ground CKT 814.

MAP SENSOR

ALTITUDE		VOLTAGE RANGE
Feet	Meters	
Below 1,000	Below 305	3.8-5.5 V
1,000-2,000	305-610	3.6-5.3 V
2,000-3,000	610-914	3.5-5.1 V
3,000-4,000	914-1219	3.3-5.0 V
4,000-5,000	1219-1524	3.2-4.8 V
5,000-6,000	1524-1829	3.0-4.6 V
6,000-7,000	1829-2133	2.9-4.5 V
7,000-8,000	2133-2438	2.8-4.3 V
8,000-9,000	2438-2743	2.6-4.2 V
9,000-10,000	2743-3048	2.5-4.0 V

LOW ALTITUDE = HIGH PRESSURE = HIGH VOLTAGE

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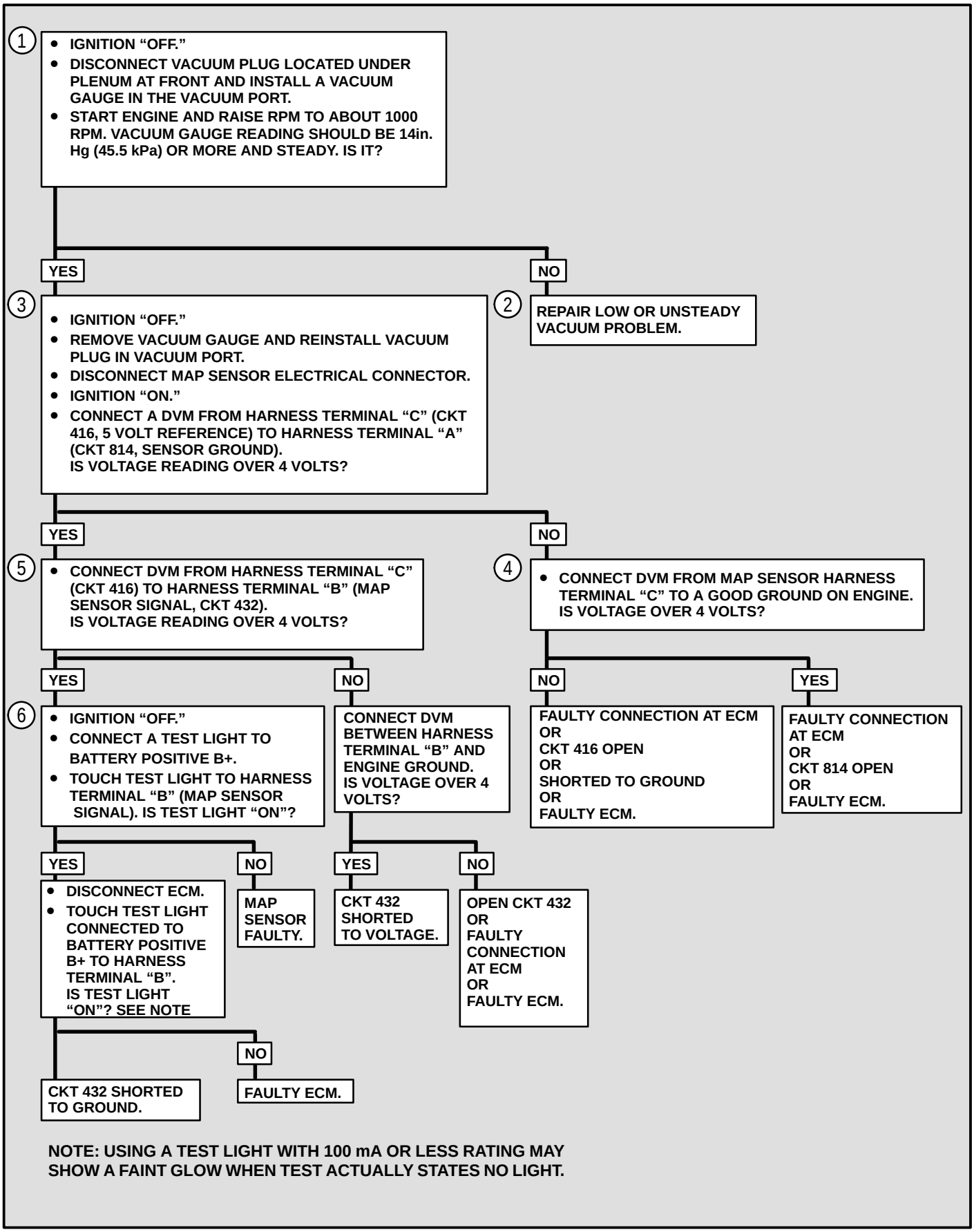
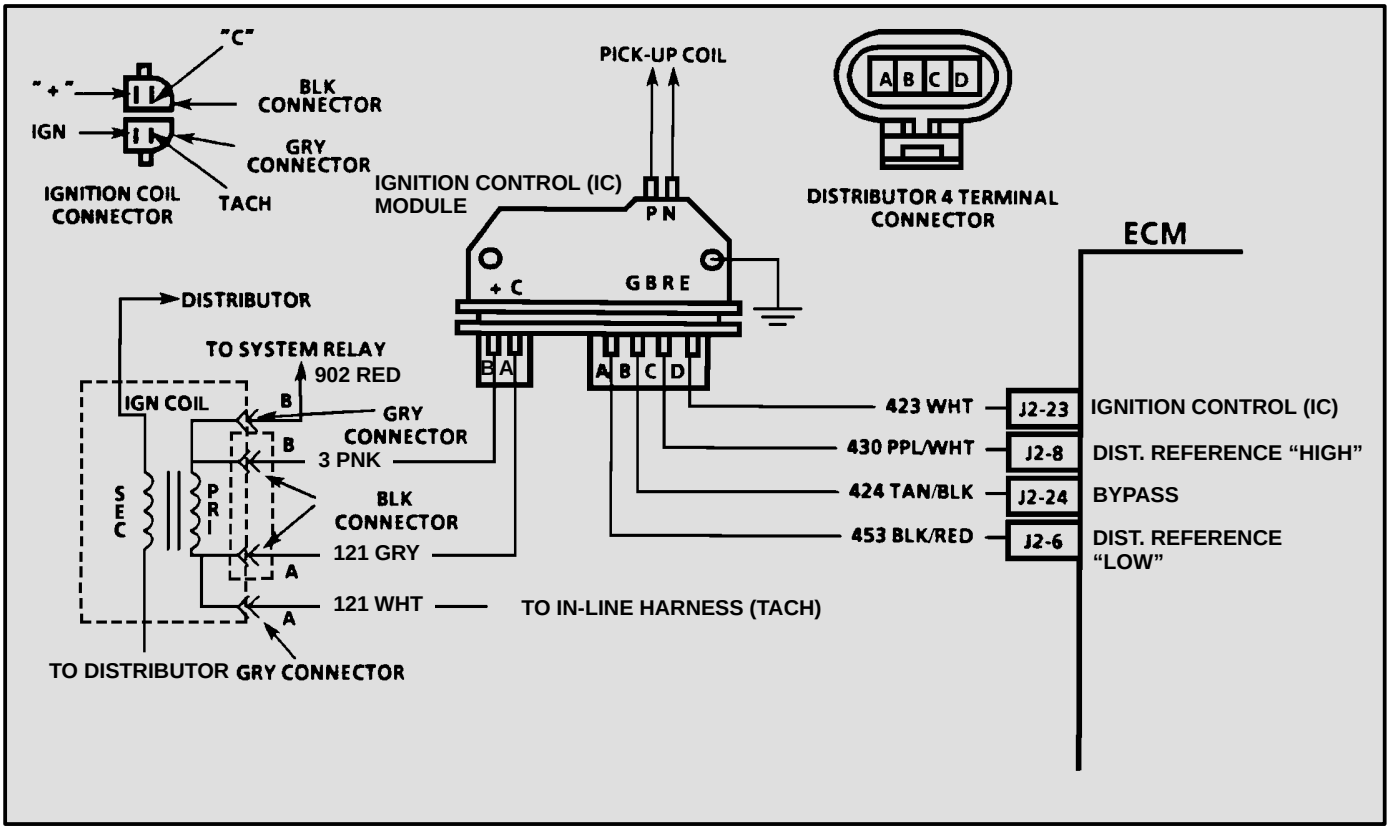
Code 33: MAP Circuit (Non-Scan)
(2 of 2)



Code 42: Ignition Control (IC) Circuit (Non-Scan) (1 of 2)



CIRCUIT DESCRIPTION:

When the system is running on the ignition module, that is, no voltage on the bypass line, the ignition module grounds the IC signal. The ECM expects to detect no voltage on the IC line during this condition. If it detects a voltage, it sets Code 42 and will not go into the IC mode.

When the RPM for IC is reached (about 300 RPM), and bypass voltage applied, the IC should no longer be grounded in the ignition module, so the IC voltage should be varying.

If the bypass line is open or grounded, the ignition module will not switch to IC mode so the IC voltage will be low and Code 42 will be set.

If the IC line is grounded, the ignition module will switch to IC but, because the line is grounded, there will be no IC signal. A Code 42 will be set.

TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

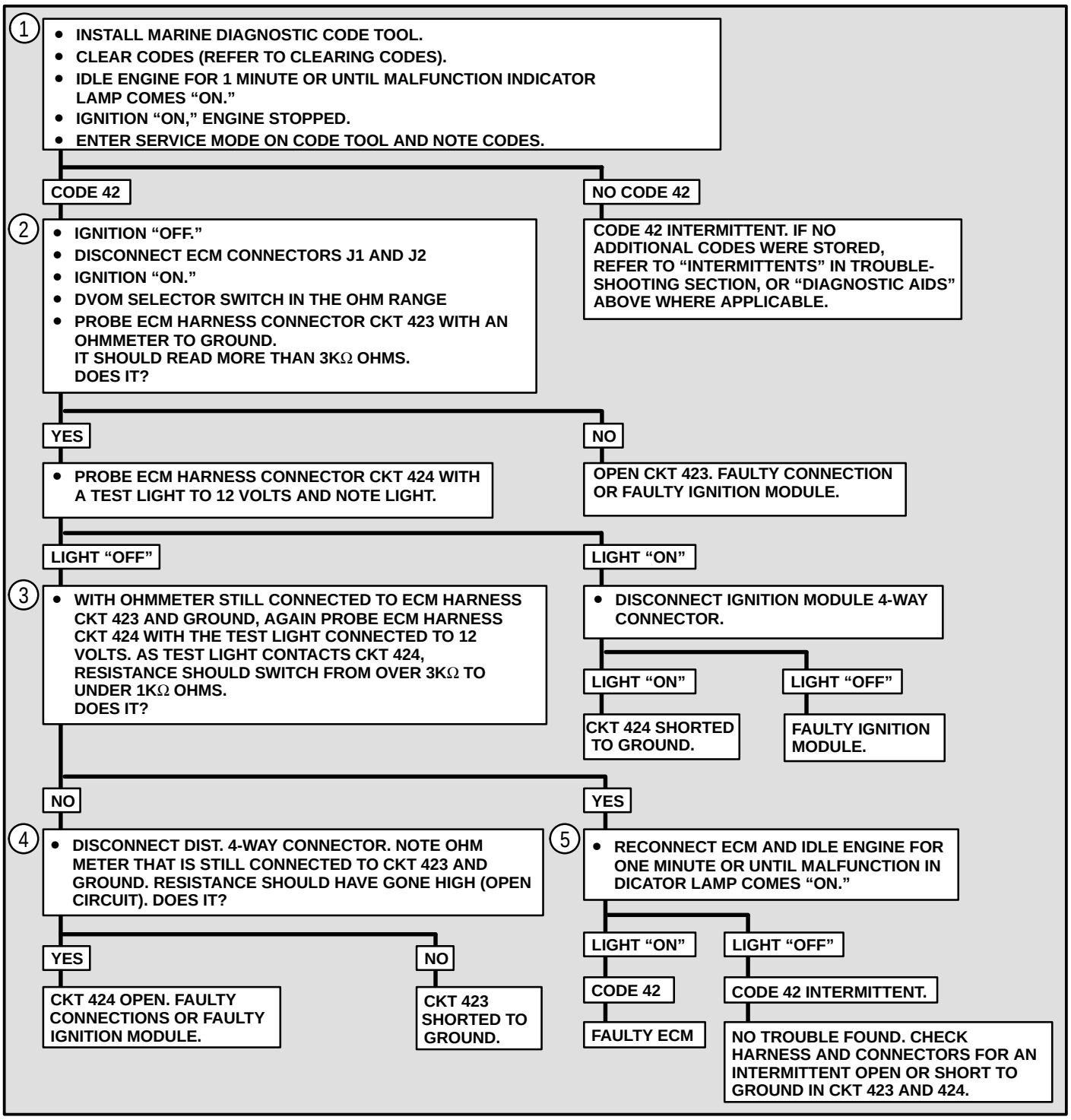
1. Code 42 means the ECM has seen an open or short to ground in the IC or bypass circuits. This test confirms Code 42 and that the fault causing the code is present.
2. Check for a normal IC ground path through the ignition module. An IC CKT 423 shorted to ground will also read more than 3000 ohms; however, this will be checked later.
3. As the test light voltage touches CKT 424, the module should switch, causing the DVM reading to go from over 3000 ohms to under 1000 ohms. The important thing is that the module "switched."
4. The module did not switch and this step checks for:
   - IC CKT 423 shorted to ground.
   - Bypass CKT 424 open.
   - Faulty ignition module connection or module.
5. Confirms that Coded 42 is a faulty ECM and not an intermittent in CKT 423 or CKT 424.

Code 42: IC Circuit (Non-Scan) (2 of 2)

DIAGNOSTIC AIDS:

An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry that is suspected as causing the intermittent complaint should be thoroughly checked for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, clear codes following “Clearing Codes” in “ECM Self-Diagnostics.” Failure to do so may result in codes not properly being cleared.



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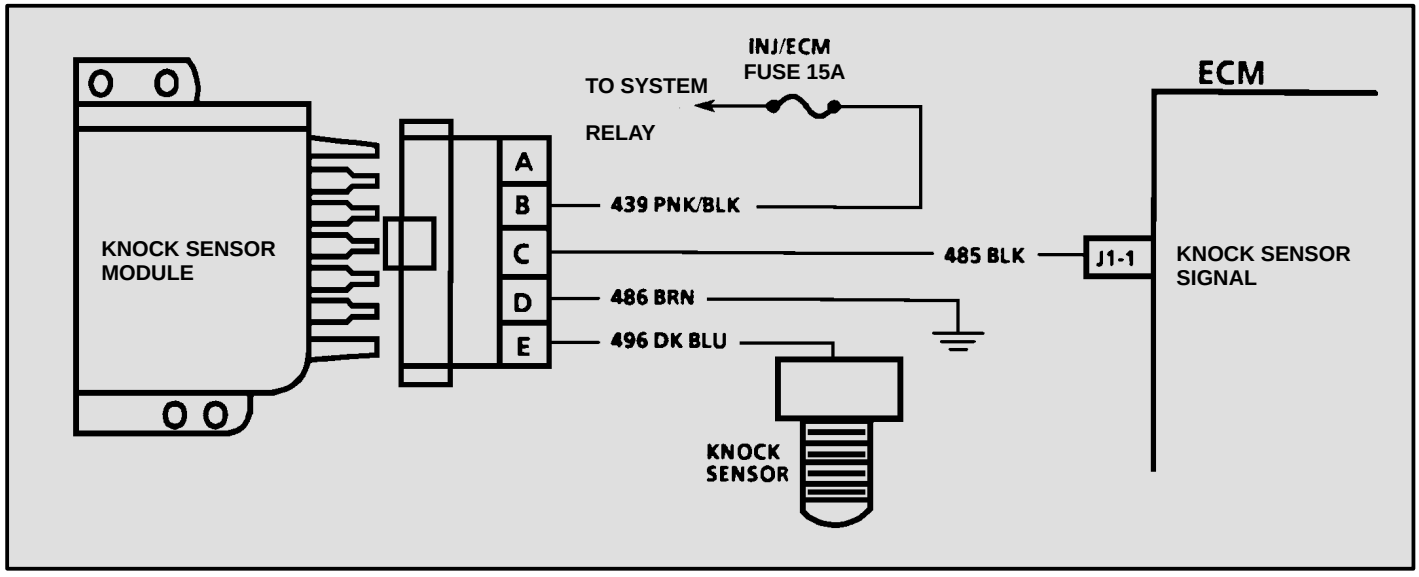
Code 43: Knock Sensor (KS) (Non-Scan)
(1 of 2)



CIRCUIT DESCRIPTION:

The ability to sense engine knock or detonation is accomplished with a module that sends a voltage signal to the ECM. As the knock sensor detects engine knock, the voltage from the KS module to the ECM drops, and this signals the ECM to retard timing.

TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. This step ensures that the knock sensor circuitry is within the proper resistance value.
2. Applying 12 volts with a test light to CKT 496 simulates a signal from the knock sensor. The knock sensor is faulty if a response occurs.
3. This step checks if a voltage signal from the KS module is present at the ECM.
4. This step determines if ignition voltage is available to power up the KS module.
5. This step confirms the ability of the KS module to remove the voltage from the signal line when it sees spark knock. Since the knock sensor produces an AC voltage signal, it may be necessary to repeatedly touch the harness connector with the test light probe to simulate this type of signal.
6. This step checks the ground circuit from the KS module. If the test light is dim, check ground (CKT 486) for excessive resistance.

DIAGNOSTIC AIDS:

If CKT 496 is routed too close to secondary ignition wires, the KS module may see the interference as a knock signal, resulting in false retard.

An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry that is suspected as causing the intermittent complaint should be thoroughly checked for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, clear codes following “Clearing Codes” in “ECM Self-Diagnostics.” Failure to do so may result in codes not properly being cleared.

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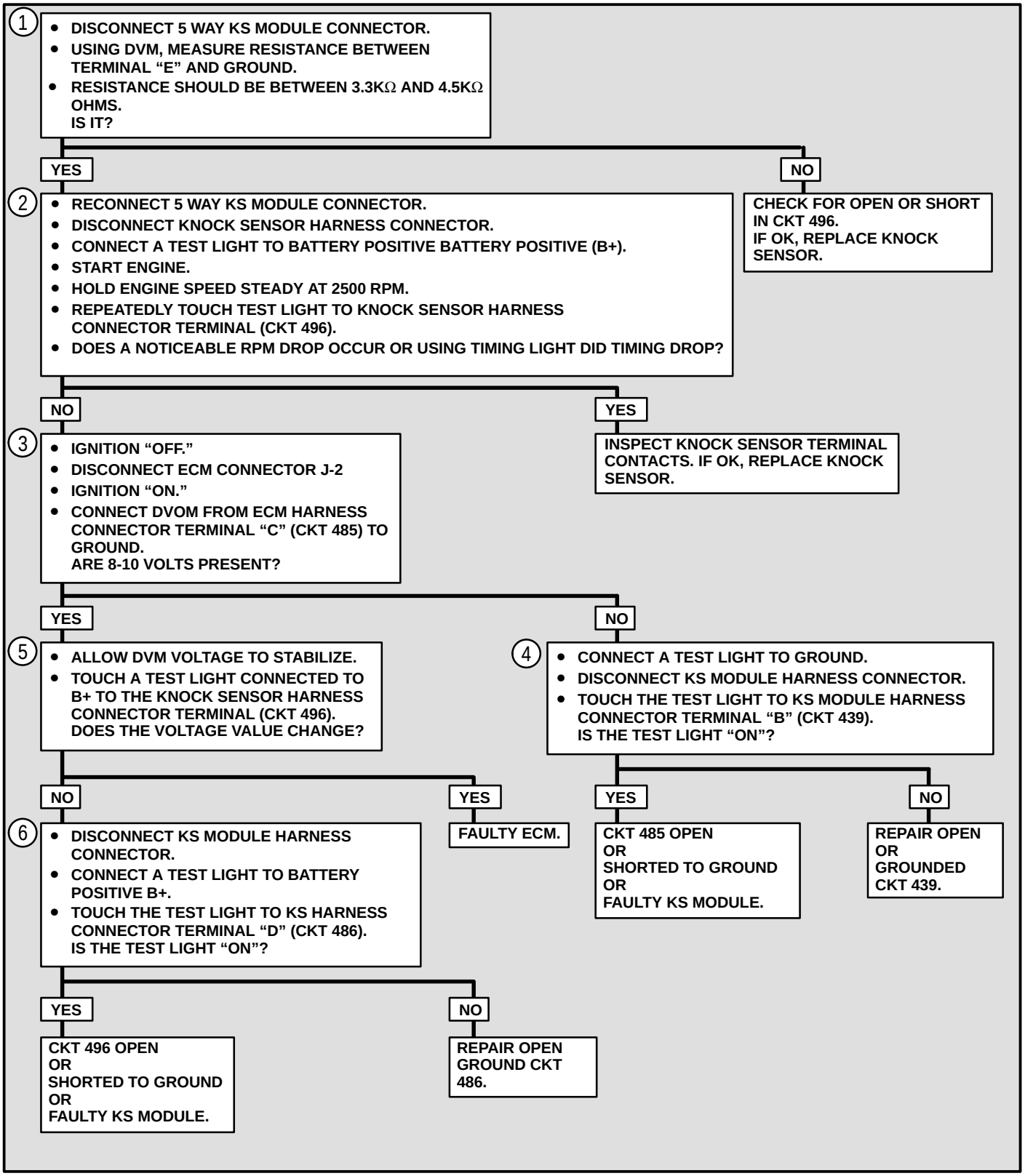
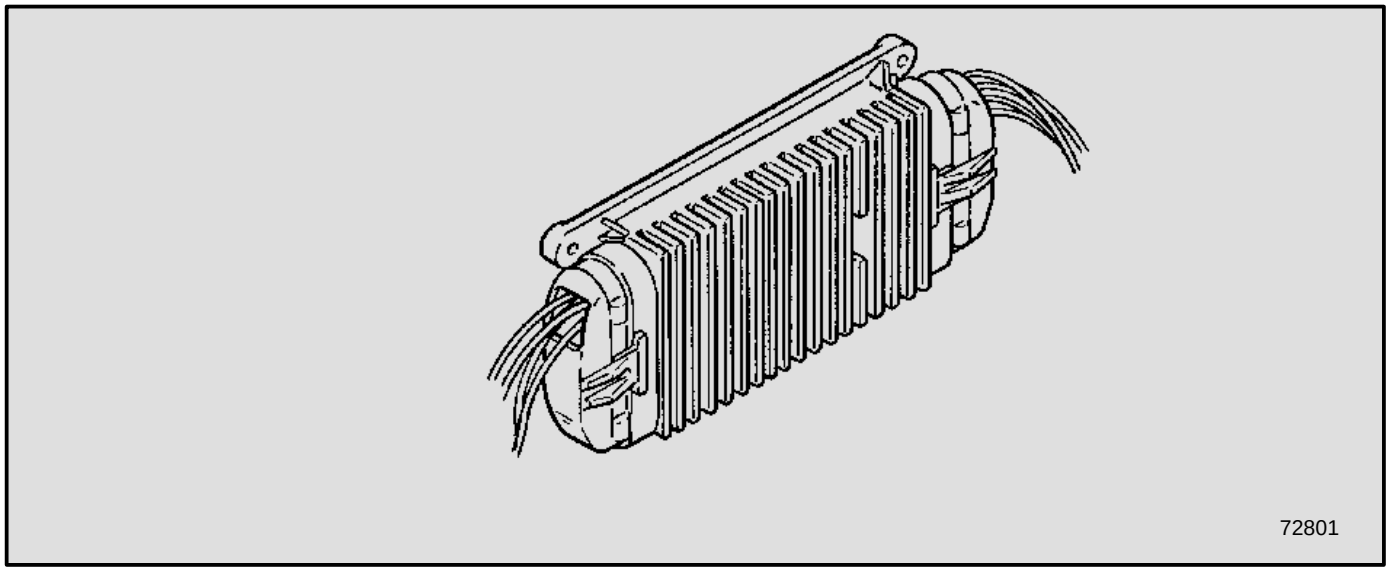
Code 43: Knock Sensor (KS) Circuit (Non-Scan)
(2 of 2)



Code 51: Calibration Memory Failure Non-Scan Diagnostics (1 of 2)



CIRCUIT DESCRIPTION:

This test allows the ECM to check for a calibration failure by comparing the calibration value to a known value stored in the EEPROM.

This test is also used as a security measure to prevent improper use of calibrations or changes to these calibrations that may alter the designed function of the EFI system.

TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. This step checks to see if the fault is present during diagnosis. If present, the ECM is not functioning correctly and must be replaced.

IMPORTANT: At the time of printing, vessels with Fuel Injection were not being field reprogrammed to correct this failure. Replacement of the ECM with a factory reprogrammed ECM is necessary if Code 51 is current and resets when clearing codes is completed.

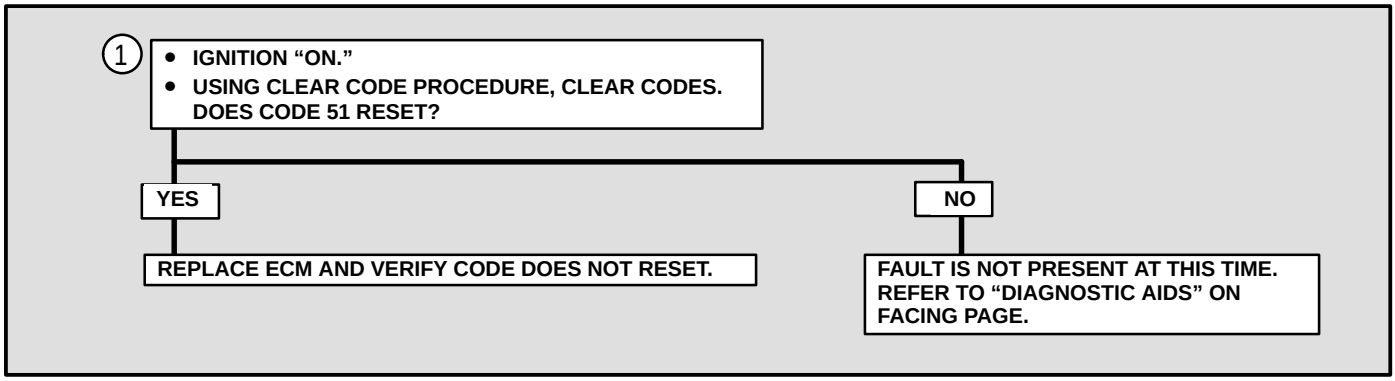
DIAGNOSTIC AIDS:

An intermittent Code 51 may be caused by a bad cell in the EEPROM that is sensitive to temperature changes. If Code 51 failed more than once, but is intermittent, replace ECM.

An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

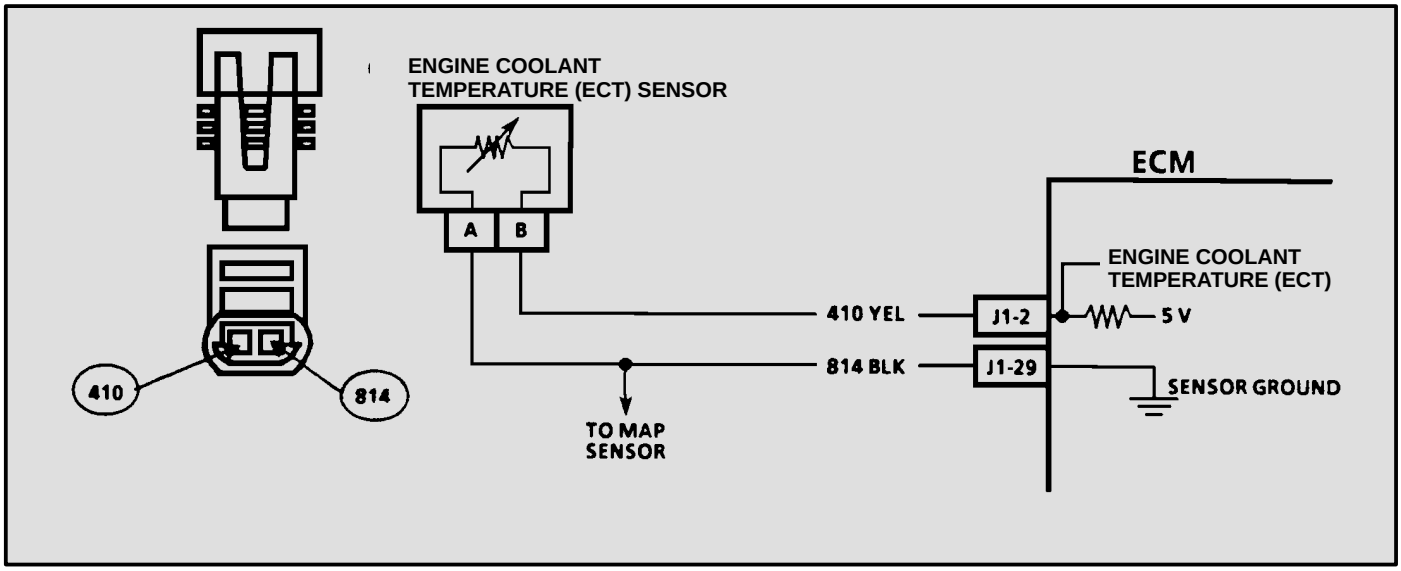
Any circuitry that is suspected as causing the intermittent complaint should be thoroughly checked for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, clear codes following “Clearing Codes” in “ECM Self-Diagnostics.” Failure to do so may result in codes not properly being cleared.

Code 51: Calibration Memory Failure (Non-Scan) (2 of 2)



Diagnostics - Using Scan Tool (Scan)

Code 14 Engine Coolant Temperature (ECT) Sensor Circuit (Scan) (1 of 2)



CIRCUIT DESCRIPTION:

The Engine Coolant Temperature (ECT) Sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies a voltage on CKT 410 to the sensor. When the engine coolant is cold, the sensor (thermistor) resistance is high, therefore, the ECM will see high signal voltage. As the engine coolant warms, the sensor resistance becomes less, and the voltage drops. At normal engine operating temperature, 160-180°F (71-82°C), the voltage will measure about 1.5 to 2.0 volts.

TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. Code 14 will set if:
   - Signal voltage indicates a coolant temperature above 266°F (130°C).
   - Signal voltage indicates a coolant temperature below –22°F (–30°C).
2. This test will determine if CKT 410 is shorted to ground, which will cause the condition for Code 14.

DIAGNOSTIC AIDS:

Check harness routing for a potential short to ground in CKT 410.

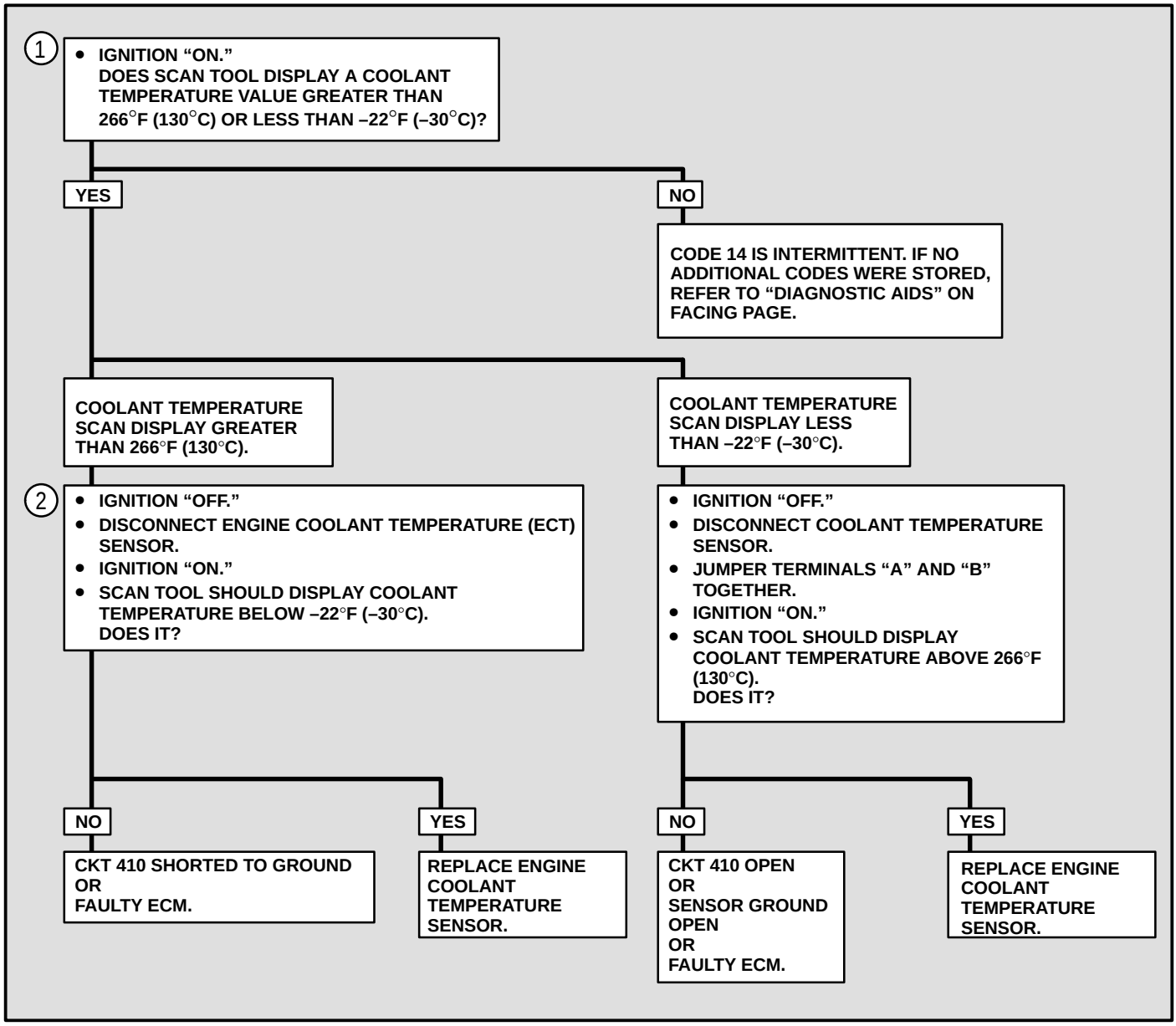
Scan tool displays engine temperature in degrees Fahrenheit and Celsius. After engine is started, the temperature should rise steadily, reach normal operating temperature, and then stabilize when thermostat opens.

See “Intermittents” in “Troubleshooting.”

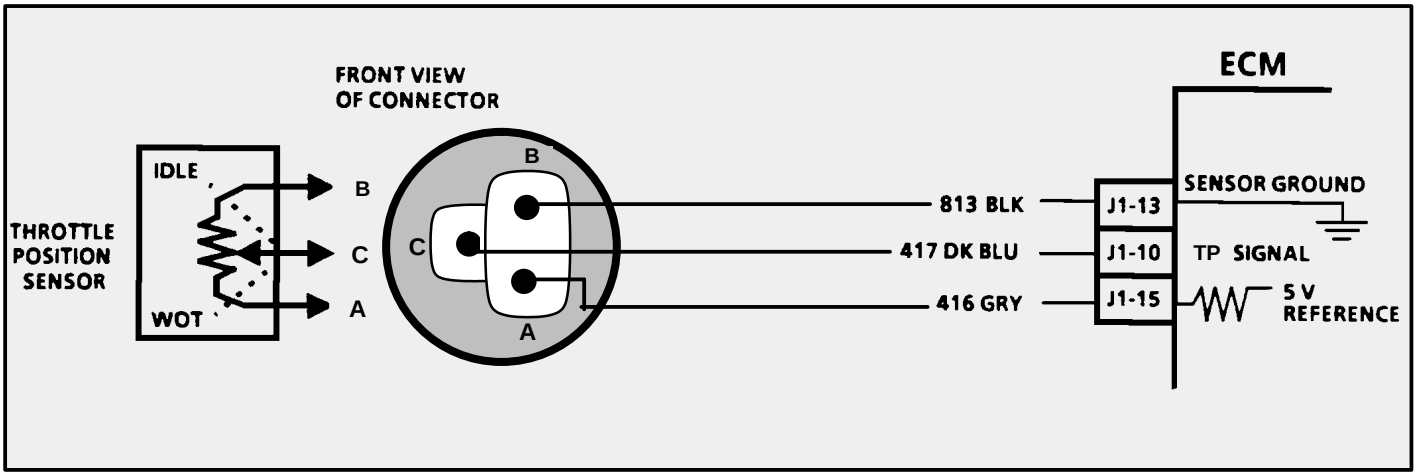
An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry that is suspected as causing the intermittent complaint should be thoroughly checked for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, clear codes following “Clearing Codes” in “ECM Self-Diagnostics.” Failure to do so may result in codes not properly being cleared.

Code 14: ECT Circuit (Scan) (2 of 2)



Code 21: Throttle Position (TP) Sensor Circuit (Scan) (1 of 2)



CIRCUIT DESCRIPTION:

The Throttle Position (TP) Sensor provides a voltage signal that changes as throttle blades open or close. Signal voltage should vary from about .7 volts at idle to about 4.5 volts at Wide Open Throttle (W.O.T.).

The TP signal is one of the most important inputs used by the Electronic Control Module (ECM) for fuel control and for most of the ECM controlled outputs.

TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. With throttle closed the TP sensor should read between .3 and .8 volt. If it does not, check throttle cable adjustment or for bent linkage.
2. With the TP sensor disconnected, the TP voltage should go low if the ECM and wiring are OK.
3. Probing CKT 813 with a DVOM to CKT 416 checks the sensor ground. A faulty sensor ground will cause a Code 21.

DIAGNOSTIC AIDS:

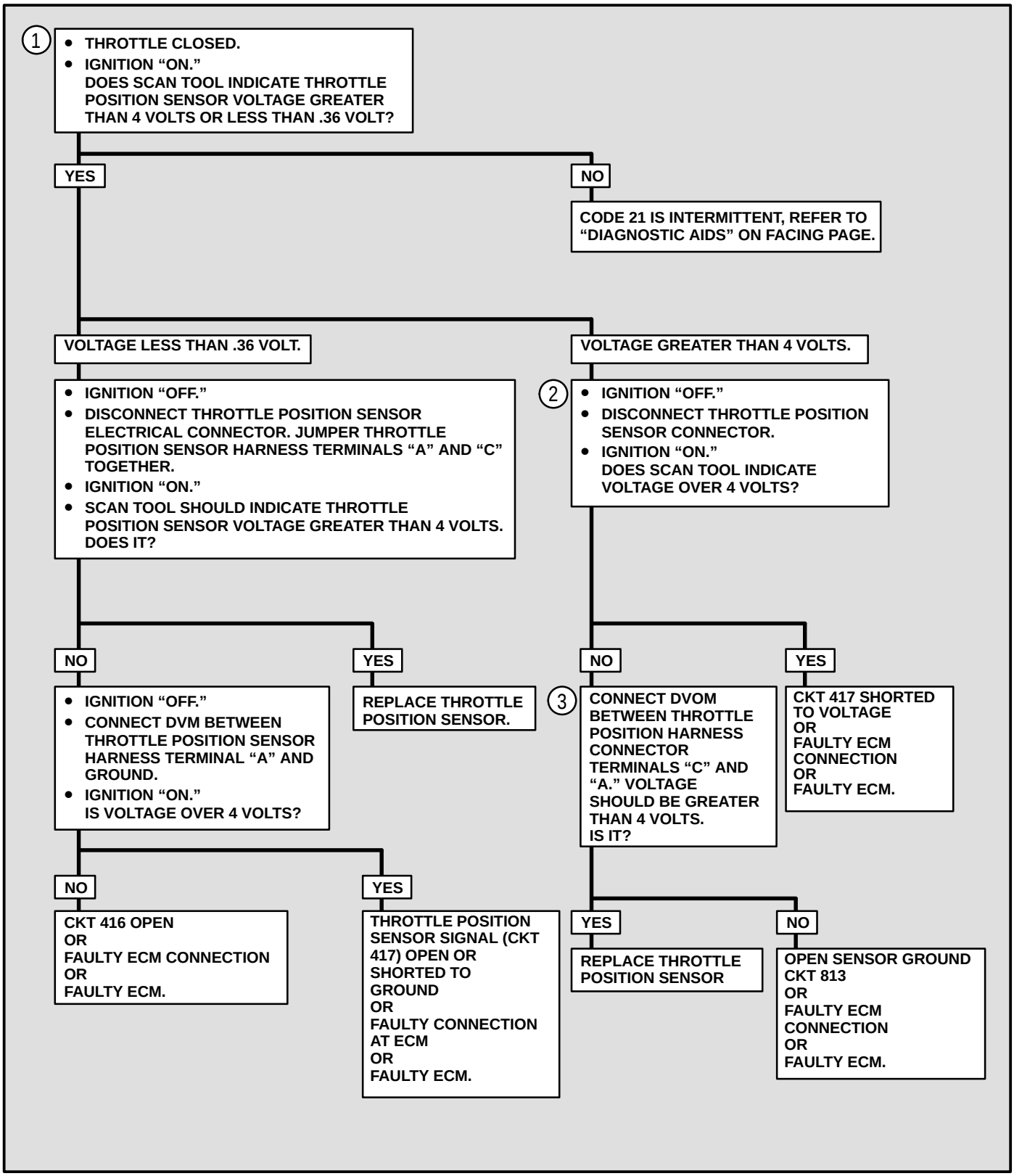
The scan tool reads throttle position in voltage and percentage of throttle blade opening. With ignition ON or at idle, TP signal voltage should read between .3 and .8 volt with the throttle closed, and increase at a steady rate as throttle is moved toward Wide Open Throttle (W.O.T.).

If Code 23 is also set, check CKT 813 for faulty wiring or connections. Check terminals at sensor for good contact.

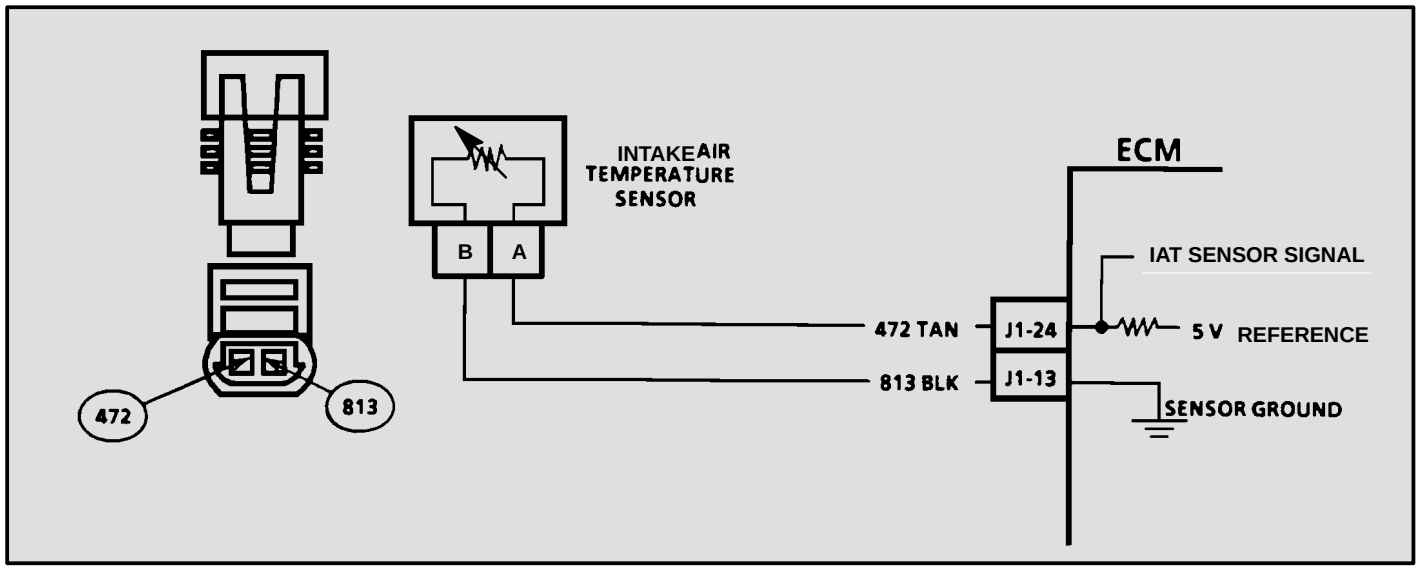
An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry that is suspected as causing the intermittent complaint should be thoroughly checked for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, clear codes following “Clearing Codes” in “ECM Self-Diagnostics.” Failure to do so may result in codes not properly being cleared.

Code 21: TP Sensor Circuit (Scan)
(2 of 2)



Code 23: Intake Air Temperature (IAT) Sensor Circuit (Scan) (1 of 2)



CIRCUIT DESCRIPTION:

The Intake Air Temperature (IAT) sensor uses a thermistor to control the signal voltage to the Electronic Control Module (ECM). The ECM applies a voltage (about 5 volts) on CKT 472 to the sensor. When the air is cold, the sensor (thermistor) resistance is high; therefore, the ECM will see a high signal voltage. If the air is warm, the sensor resistance is low; therefore, the ECM will see a low voltage.

TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. A Code 23 will set, due to an open sensor, wire or connection. This test will determine if the wiring and ECM are OK. If the scan tool indicates a temperature of over 266°F (130°C), the jumper harness to the sensor should be checked before replacing the sensor.
2. This will determine if the IAT sensor signal (CKT 472) or the IAT sensor ground (CKT 813) is open.
3. This step will determine if the fault is in the IAT sensor or the circuit.

DIAGNOSTIC AIDS:

The scan tool reads temperature of the air entering the engine and should read close to ambient air temperature when engine is cold, and rises as engine compartment temperature increases.

The IAT sensor in this engine is located on the starboard underside of the plenum.

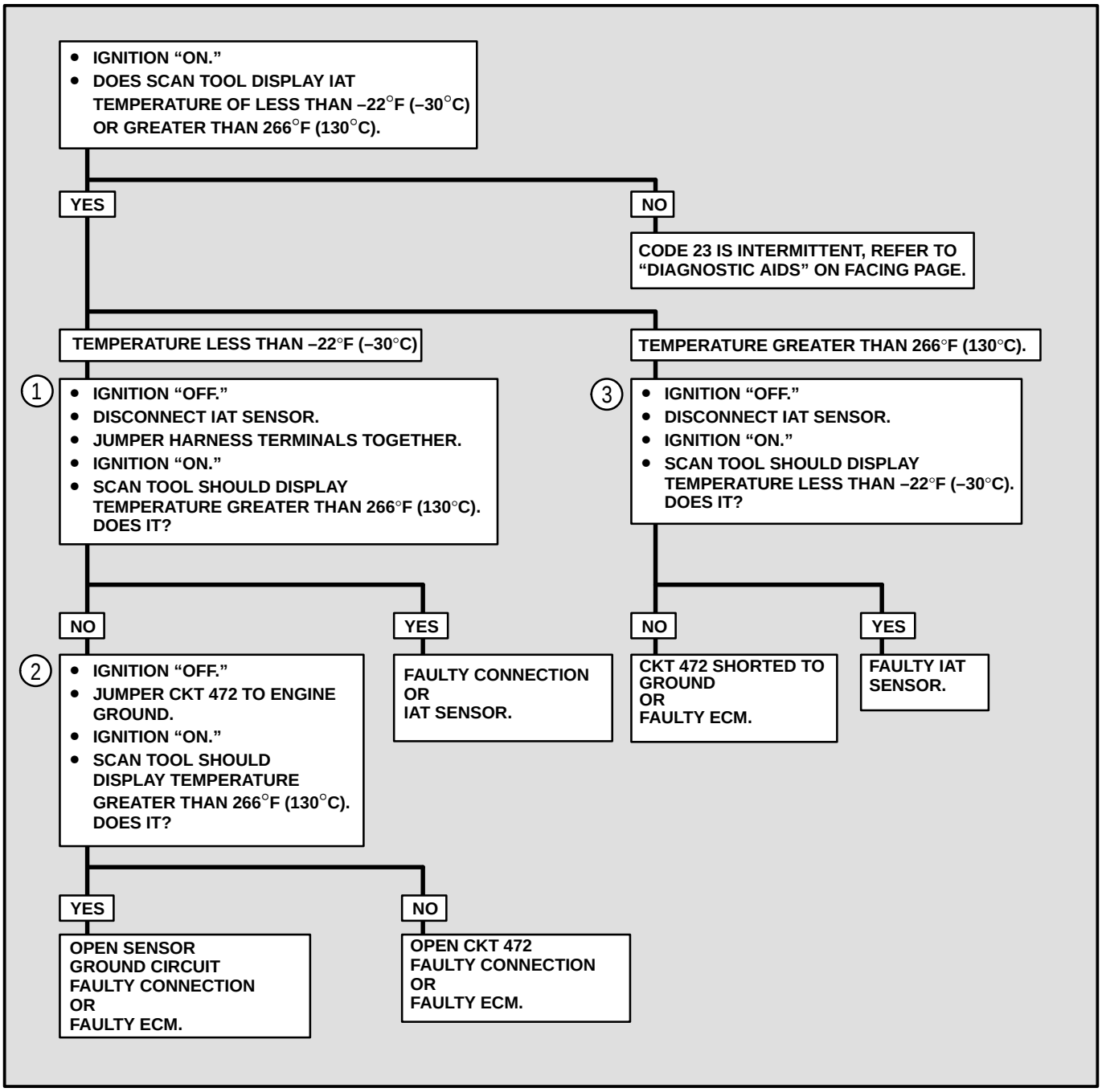
Carefully check harness and connections for possible open.

If the engine has been allowed to sit overnight, the intake air temperature and coolant temperature values should read within a few degrees of each other.

An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

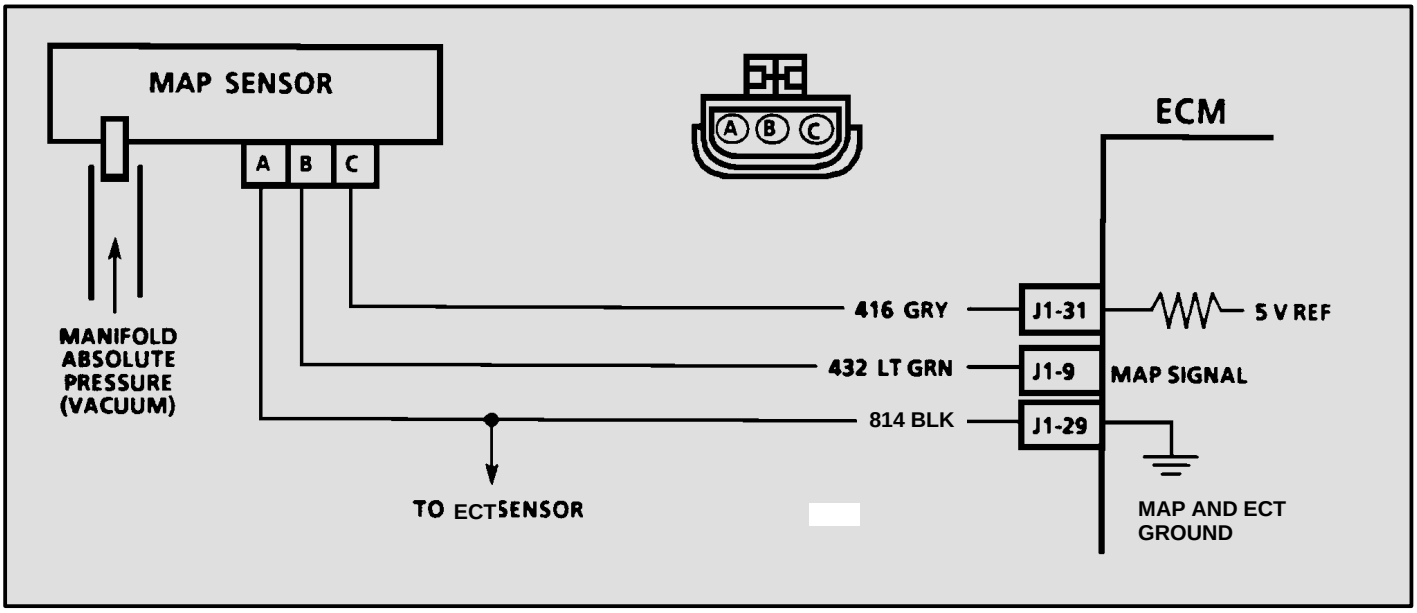
Any circuitry that is suspected as causing the intermittent complaint should be thoroughly checked for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, clear codes following “Clearing Codes” in “ECM Self-Diagnostics.” Failure to do so may result in codes not properly being cleared.

Code 23: IAT Circuit (Scan)
(2 of 2)



Index

Code 33: Manifold Absolute Pressure (MAP) Sensor Circuit (Scan) (1 of 2)



CIRCUIT DESCRIPTION:

The Manifold Absolute Pressure (MAP) sensor responds to changes in manifold pressure (vacuum). The ECM receives this information as a signal voltage that will vary from about 1-1.5 volts at closed throttle idle, to 4.0-4.8 volts at Wide Open Throttle (W.O.T.) (low vacuum).

The scan tool displays manifold pressure in kPa of pressure and voltage. Low pressure (high vacuum) reads a low voltage while a high pressure (low vacuum) reads a high voltage.

If the MAP sensor fails, the ECM will substitute a fixed MAP value and use engine RPM to control fuel delivery.

TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. Engine misfire or a low unstable idle may set Code 33. Disconnect MAP sensor and system will go into backup mode. If the misfire or idle condition remains, refer to “Troubleshooting.”
2. If the ECM recognizes the low MAP signal, the ECM and wiring are OK.

DIAGNOSTIC AIDS:

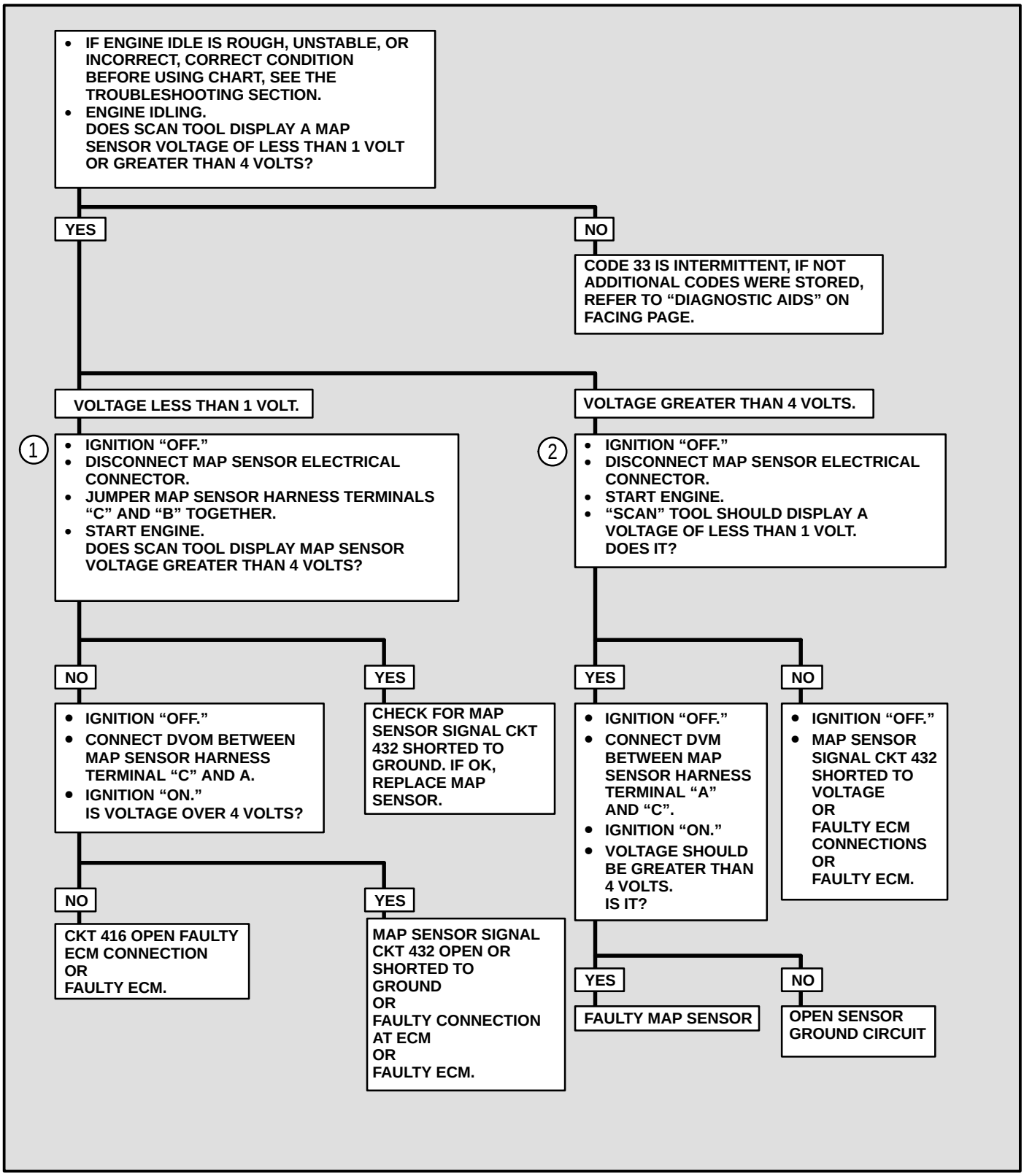
If the idle is rough or unstable, refer to “Troubleshooting” for items which can cause an unstable idle.

With the ignition ON and the engine OFF, the manifold pressure is equal to atmospheric pressure and the signal voltage will be high. This information is used by the ECM as an indication of vessel altitude and is referred to as BARO. Comparison of this BARO reading, with a known good vessel with the same sensor, is a good way to check accuracy of a “suspect” sensor. Reading should be the same, $\pm$ .4 volt.

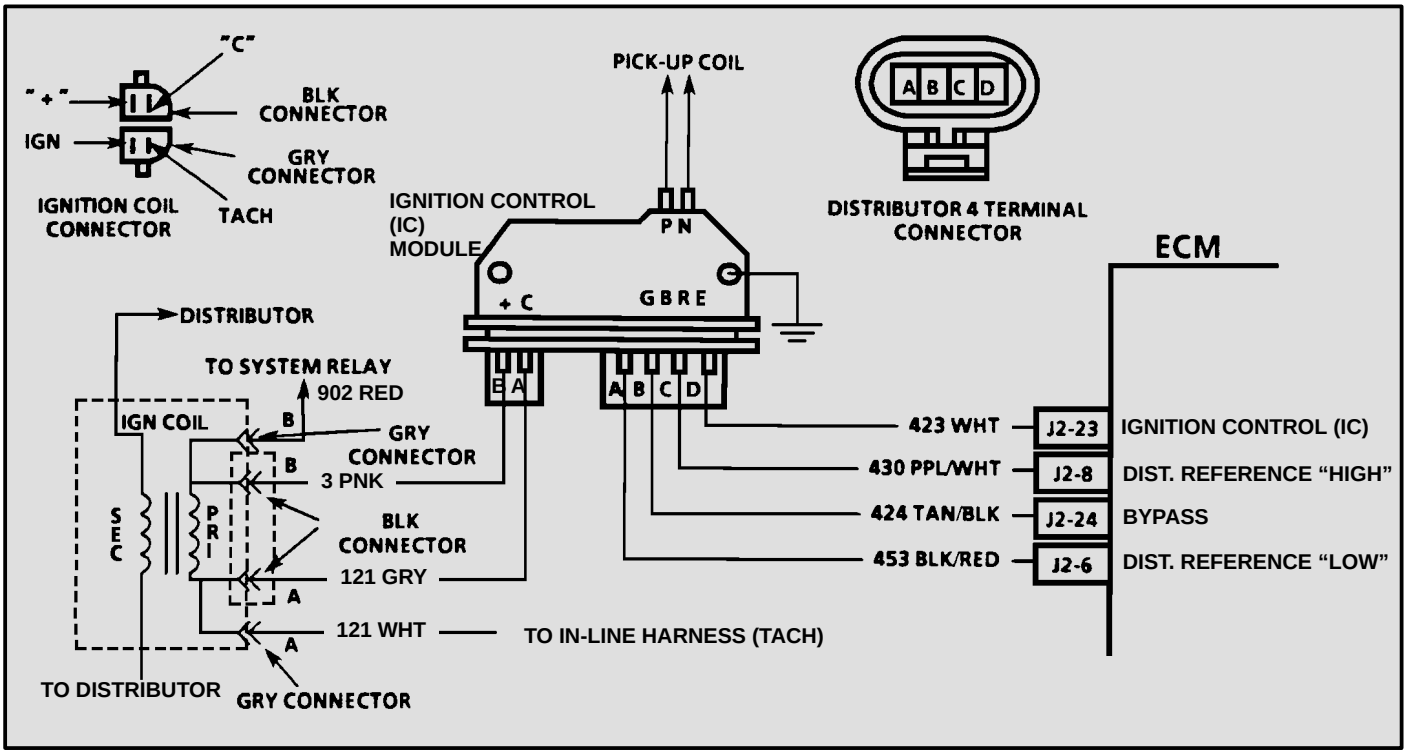
An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry that is suspected as causing the intermittent complaint should be thoroughly checked for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, clear codes following “Clearing Codes” in “ECM Self-Diagnostics.” Failure to do so may result in codes not properly being cleared.

Code 33: MAP Circuit (Scan)
(2 of 2)



Code 42: Ignition Control (IC) Circuit (Scan) (1 Of 2)



CIRCUIT DESCRIPTION:

When the system is running on the ignition module, that is, no voltage on the bypass line, the ignition module grounds the IC signal. The ECM expects to detect a low voltage on the IC line during this condition. If it detects a voltage, it sets Code 42 and will not go into the IC mode.

When the RPM for IC is reached (about 300 RPM), and bypass voltage applied, the IC should no longer be grounded in the ignition module, so the IC voltage should be varying.

If the bypass line is open or grounded, the ignition module will not switch to IC mode so the IC voltage will be low and Code 42 will be set.

If the IC line is grounded, the ignition module will switch to IC but, because the line is grounded, there will be no IC signal. A Code 42 will be set.

TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. Code 42 means the ECM has seen an open or short to ground in the IC or bypass circuits. This test confirms Code 42 and that the fault causing the code is present.
2. Check for a normal IC ground path through the ignition module. An IC CKT 423 shorted to ground will also read more than 3000 ohms; however, this will be checked later.
3. As the test light voltage touches CKT 424, the module should switch, causing the DVOM reading to go from over 3000 ohms to under 1000 ohms. The important thing is that the module "switched."
4. The module did not switch and this step checks for:
   - IC CKT 423 shorted to ground.
   - Bypass CKT 424 open.
   - Faulty ignition module connection or module.
5. Confirms that Coded 42 is a faulty ECM and not an intermittent in CKT 423 or CKT 424.

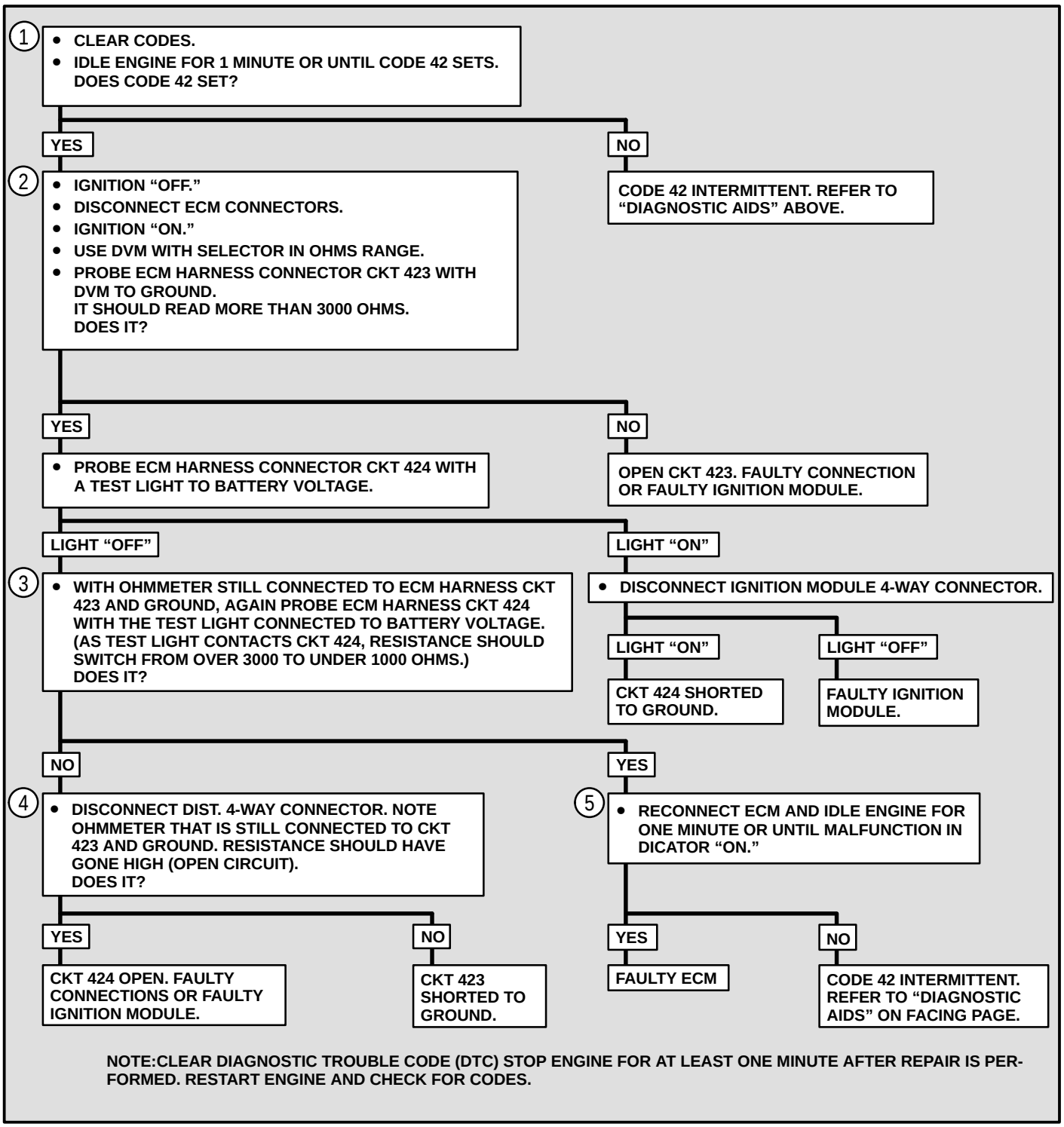
Code 42: IC Circuit (Scan) (2 of 2)

DIAGNOSTIC AIDS:

Refer to “Intermittents” in “Troubleshooting.”

An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry that is suspected as causing the intermittent complaint should be thoroughly checked for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, clear codes following “Clearing Codes” in “ECM Self-Diagnostics.” Failure to do so may result in codes not properly being cleared.



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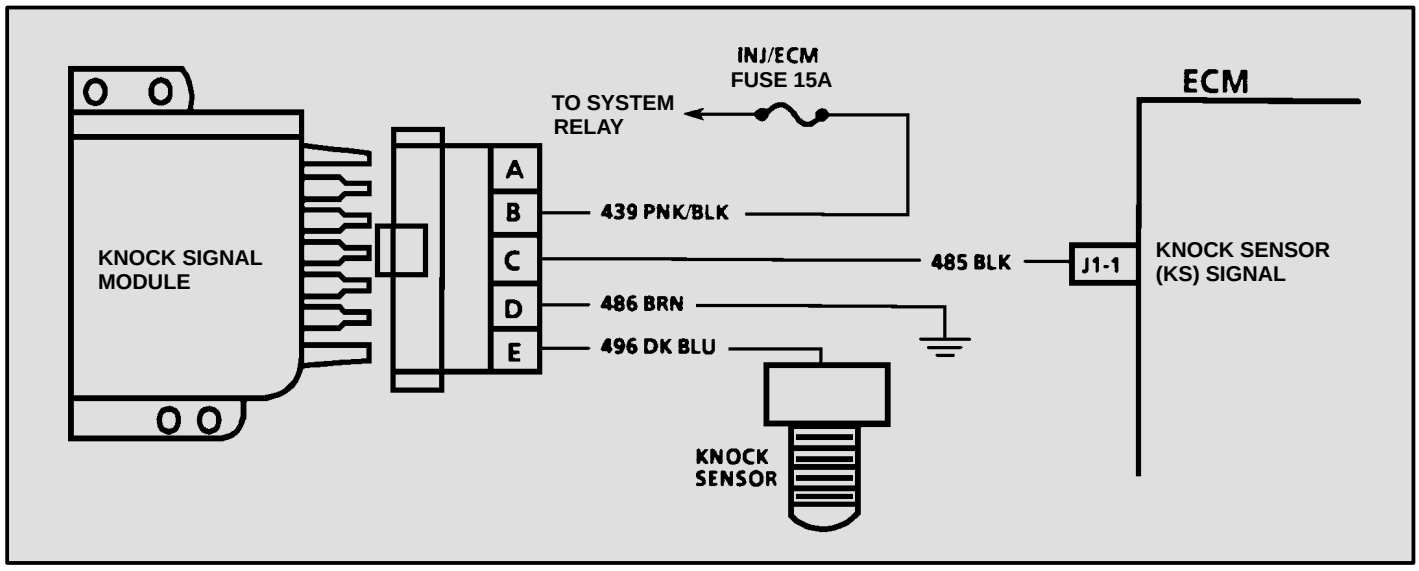
Code 43: Knock Sensor (KS) (Scan)
(1 Of 2)



CIRCUIT DESCRIPTION:

Sensing engine detonation or spark knock is accomplished with a module that sends a voltage signal to the ECM. As the knock sensor detects engine knock, the voltage from the KS module to the ECM drops, and this signals the ECM to retard timing. The ECM will retard the timing when knock is detected and RPM is above a certain value.

TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. This step determines if there is a problem in the circuit. When an KS circuit fails, the ECM will switch to a default value of about 3.2 degrees of timing retard.
2. This step checks if there is a voltage source to the knock sensor from the KS module.
3. This step will determine if the knock sensor is faulty.

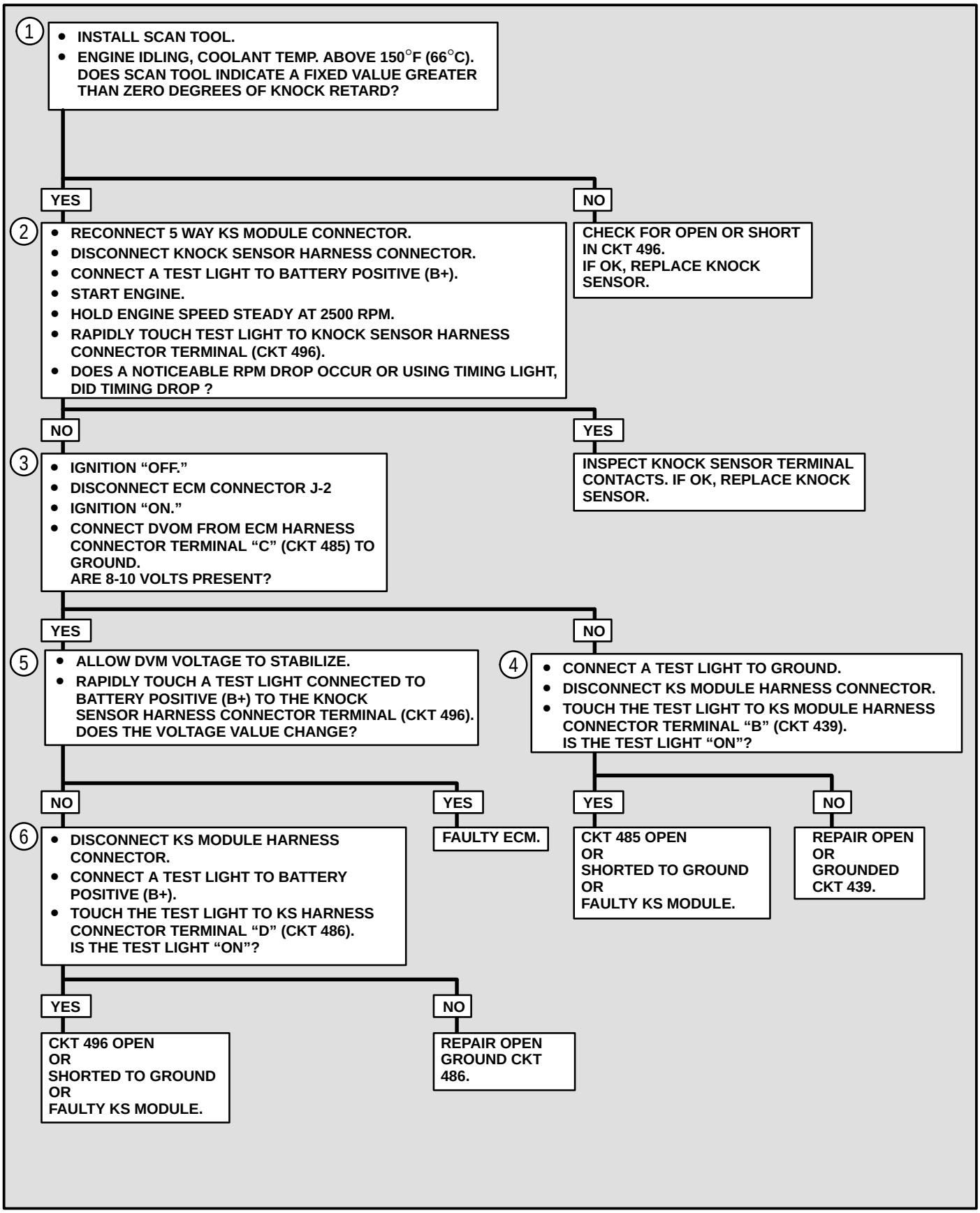
DIAGNOSTIC AIDS:

If CKT 496 is routed too close to secondary ignition wires, the KS module may see the interference as a knock signal, resulting in false retard.

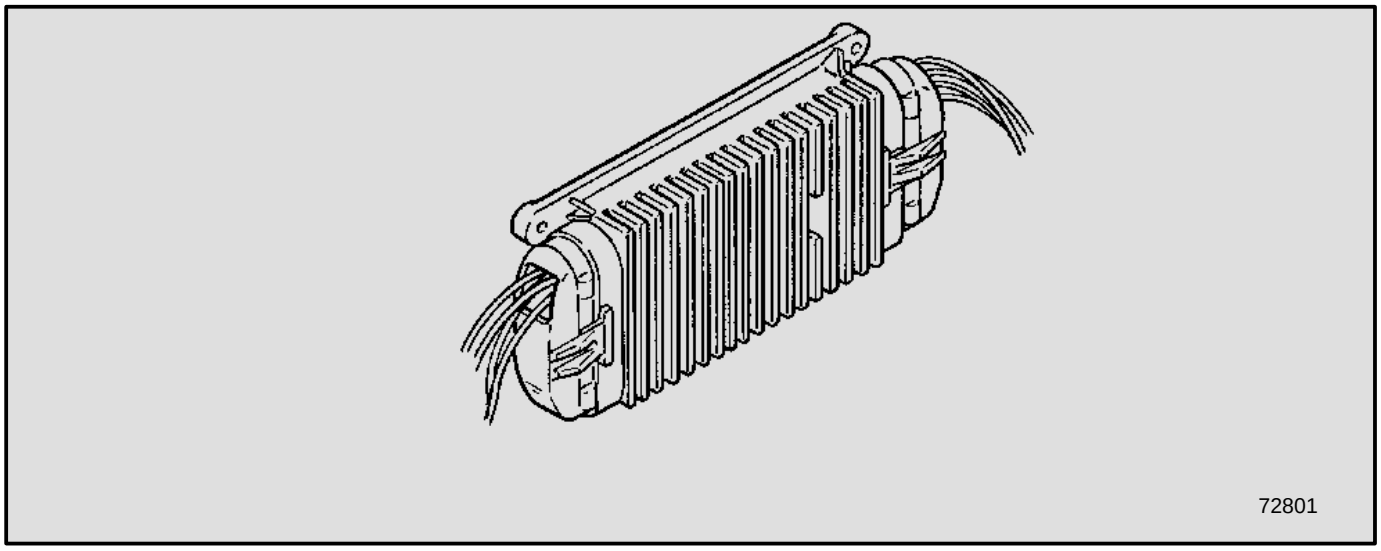
An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry that is suspected as causing the intermittent complaint should be thoroughly checked for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, clear codes following “Clearing Codes” in “ECM Self-Diagnostics.” Failure to do so may result in codes not properly being cleared.

Code 43: KS Circuit (Scan)
(2 of 2)



Code 51: Calibration Memory Failure (Scan) (1 Of 2)



CIRCUIT DESCRIPTION:

This test allows the ECM to check for a calibration failure by comparing the calibration value to a known value stored in the EEPROM.

This test is also used as a security measure to prevent improper use of calibrations or changes to these calibrations that may alter the designed function of EFI.

TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. This step checks to see if the fault is present during diagnosis. If present, the ECM is not functioning correctly and must be replaced.

IMPORTANT: At the time of printing, vessels with fuel injection were not being field reprogrammed to correct this failure. Replacement of the ECM with a factory reprogrammed ECM is necessary if Code 51 is current and resets when clearing codes is completed.

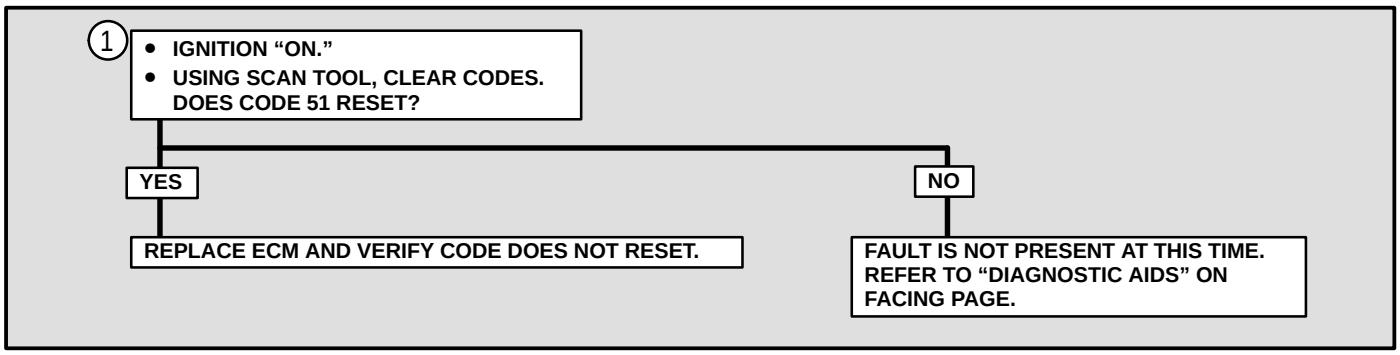
DIAGNOSTIC AIDS:

An intermittent Code 51 may be caused by a bad cell in the EEPROM that is sensitive to temperature changes. If Code 51 failed more than once, but is intermittent, replace ECM.

An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry that is suspected as causing the intermittent complaint should be thoroughly checked for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, clear codes following “Clearing Codes” in “ECM Self-Diagnostics.” Failure to do so may result in codes not properly being cleared.

Code 51: Calibration Memory Failure (Scan) (2 of 2)



Troubleshooting

Changes In Terminology

Due to industry standardization of terminology for certain electronic engine controls some names and abbreviations have changed.

From	To
(CTS) Coolant Temperature Sensor	(ECT) Engine Coolant Temperature
(TPS) Throttle Position Sensor	(TP) Throttle Position
(MAT) Manifold Air Temperature	(IAT) Intake Air Temperature
(EST) Electronic Spark Timing	(IC) Ignition Control
(ESC) Electronic Spark Control	(KS) Knock Sensor
(ALDL) Assembly Line Data Link	(DLC) Data Link Connector

Diagnostic Trouble Codes

Code Number	Code Description
Code 14	(ECT) Engine Coolant Temperature
Code 21	(TP) Throttle Position Sensor
Code 23	(IAT) Intake Air Temperature
Code 33	(MAP) Manifold Absolute Pressure
Code 42	(IC) Ignition Control
Code 43	(KS) Knock Sensor
Code 51	Calibration Memory Failure

Important Preliminary Checks

Before using this section, you should verify the customer complaint, and locate the correct symptom. Check the items indicated under that symptom.

Several of the following symptom procedures call for a careful visual/physical check.

The importance of this step cannot be stressed too strongly, it can lead to correcting a problem without further checks and can save valuable time.

1. Ensure that engine is in good mechanical condition.
2. Vacuum hoses for splits, kinks and proper connections
3. Air leaks at throttle body, plenum and intake manifold.
4. Ignition wires for cracking, hardness and proper routing.
5. Wiring for proper connections, pinches, and cuts. If wiring harness or connector repair is necessary.

Troubleshooting Charts

IMPORTANT PRELIMINARY CHECKS

BEFORE USING THIS SECTION

Before using this section you should have performed the “EFI Diagnostic Circuit Check” and determined that:

1. The ECM is operating correctly.
2. There are no diagnostic trouble codes (DTC) stored.

SYMPTOM

Verify the customer complaint, and locate the correct symptom. Check the items indicated under that symptom.

VISUAL/PHYSICAL CHECK

Several of the symptom procedures call for a careful visual/physical check. The importance of this step cannot be stressed too strongly. It can lead to correcting a problem without further checks and can save valuable time. These checks should include:

1. ECM grounds and sensors for being clean, tight and in their proper locations.
2. Vacuum hoses for splits, kinks, and proper connections. Check thoroughly for any type of leak or restriction.
3. Air leaks at throttle body mounting area and intake manifold sealing surfaces.
4. Ignition wires for cracking, hardness, proper routing and carbon tracking.
5. Wiring for proper connections, pinches and cuts.
6. Moisture in distributor cap, primary or secondary ignition circuit connections.
7. Salt corrosion on electrical connections and exposed throttle body linkages.
8. Ensure engine is in good mechanical condition.

INTERMITTENTS

Definition: Problem occurs randomly. May or may not store a Diagnostic Trouble Code (DTC).

DO NOT use the diagnostic trouble code charts for intermittent problems, unless instructed to do so. If a fault is intermittent, incorrect use of diagnostic trouble code charts may result in replacement of good parts.

Most intermittent problems are caused by faulty electrical connections or wiring. Perform careful check of suspected circuits for:

1. Poor mating of the connector halves or terminals not fully seated in the connector body (backed out or loose).
2. Improperly formed or damaged terminals and or connectors. All connector terminals and connectors in problem circuit should be carefully reformed or replaced to insure proper contact tension.
3. Poor terminal to wire connection (crimping).

An intermittent may be caused by:

1. Electrical system interference caused by a sharp electrical surge. Normally, the problem will occur when the faulty component is operated.
2. Improper installation of electrical options, such as lights, ship to shore radios, sonar, etc.
3. Improperly routed knock sensor wires. Wires should be routed **AWAY** from spark plug wires, ignition and charging system components.
4. Secondary ignition shorted to ground.
5. Arching at spark plug wires, spark plugs or open ignition coil ground (coil mounting brackets). Part of internal circuitry shorted to ground such as in starters, relays and alternators.

If a visual/physical check does not find the cause of the problem, the EFI system can be tested with a voltmeter or a scan tool connected while observing the suspected circuit. An abnormal reading, when the problem occurs, indicates the problem may be in that circuit.

HARD START

Definition: Engine cranks OK, but does not start for a long time. Engine does eventually run, or may start but immediately dies.

PRELIMINARY CHECKS

Make sure proper starting procedure is being used. See Owner's Manual.

Perform the careful visual/physical checks as described at the start of "Troubleshooting Charts" section.

CHECK FUEL SYSTEM FOR:

1. Proper operation of fuel pump relay. Relay will operate fuel pump for 2 seconds when ignition is turned "ON." Also look for open in CKT 465, fuel pump relay driver.
2. Clogged or dirty water separating fuel filter.
3. Contaminated fuel or winter grade fuel during warm weather.
4. Vapor lock condition or engine flooding. Check fuel pressure.
5. VST fault-stuck float, leaking vapor regulator.
6. Electric fuel pump check valve or fuel pressure regulator and / or fuel damper leaking.

CHECK IGNITION SYSTEM FOR:

1. Proper ignition timing.
2. Ignition wires for cracking, hardness and proper connections at both distributor cap and spark plugs.
3. Wet plugs, cracks, wear, improper gap, burned electrodes, or heavy deposits. Repair or replace as necessary.
4. Distributor cap inside and out for moisture, dust, cracks, burns, and arcing to coil mounting screws.
5. Worn distributor shaft. Bare and shorted wires. Pick-up coil resistance and connections. Try to turn distributor shaft by hand. Drive pin may be broken.

HARD START (continued)

CHECK SENSORS AND CONTROLS FOR:

1. Possible open in Engine Coolant Temperature (ECT) sensor and Manifold Absolute Pressure (MAP) sensor Ground CKT 814. Also may have set a DTC 14 and/or DTC 33.
2. Throttle Position (TP) sensor,ground CKT 813 could have a possible open and set DTC 21.
3. A sticking throttle shaft or binding linkage causes a high Throttle Position (TP) sensor voltage. Using a scan tool and/or voltmeter, TP sensor voltage should read less than .7 volt with throttle closed.
4. Proper Idle Air Control (IAC) operation.

CHECK ENGINE FOR:

1. Restricted exhaust.
2. Proper cylinder compression.
3. Proper camshaft timing/valve train problem.

SURGES

Definition: Engine power variation under steady throttle or cruise. Feels like the engine speeds up and slows down with no change in the throttle control.

PRELIMINARY CHECKS

Perform the visual/physical checks as described at the start of “Troubleshooting Charts” section.

CHECK FUEL SYSTEM FOR:

1. Fuel pressure to be within specification while condition exists.

CHECK IGNITION SYSTEM FOR:

1. Condition of 4-terminal Ignition Control (IC) connector at distributor. Connector wires must not be routed near spark plug wires.
2. Intermittent ground connection on ignition coil.
3. Proper operation (advancing or retarding) of Ignition Control (IC).
4. Condition of distributor cap, rotor, and spark plug wires.
5. Proper and clean connection on distributor pick-up coil terminal.
6. Spark plugs that may be fuel fouled, cracked, worn, improperly gapped, burned electrodes, or heavy deposits. Repair or replace as necessary.

CHECK SENSORS AND CONTROLS FOR:

1. Intermittent opens in Manifold Absolute Pressure (MAP) or Engine Coolant Temperature (ECT) sensor grounds CKT 814. If intermittent for a very brief period, will not set DTC.
2. Intermittent short to grounds or opens in Manifold Absolute Pressure (MAP) sensor 5 volt reference CKT 416 and Manifold Absolute Pressure (MAP) sensor signal CKT 432. If intermittent for a very brief period, will not set DTC.

SURGES (continued)

ADDITIONAL CHECKS FOR:

1. Proper alternator output voltage.
2. Leaks or kinks in vacuum lines.
3. Power reduction mode activated (if equipped)
4. Clean and tight ECM grounds and in their proper locations.

HESITATION, SAG OR STUMBLE

Definition: Momentary lack of response as the throttle is opened. Can occur at all engine speeds. May cause engine to stall if severe enough.

PRELIMINARY CHECKS

Perform the visual/physical checks as described at the start of “Troubleshooting Charts” section.

CHECK FUEL SYSTEM FOR:

1. Water contaminated fuel and dirty or restricted fuel filter
2. Fuel pressure within specification.
3. Proper functioning of fuel injectors.
4. Worn throttle linkage.

CHECK IGNITION SYSTEM FOR:

1. Ignition Control (IC) system for proper timing and advancing.
2. Faulty spark plug wires, fouled or improperly gapped spark plugs.
3. Power reduction mode activated (if equipped)
4. Knock Sensor (KS) system operational.

HESITATION, SAG OR STUMBLE (continued)

CHECK SENSORS AND CONTROLS FOR:

1. Binding or sticking Throttle Position (TP) sensor or salt corrosion. Throttle Position (TP) sensor voltage should increase as throttle is moved toward Wide Open Throttle (WOT).
2. Throttle Position (TP) sensor-5 volt reference CKT 416 for open, DTC 21 may be set.
3. Throttle Position (TP) sensor circuit for open or grounds, DTC 21 may be set.
4. Manifold Absolute Pressure (MAP) output voltage check.
5. Coolant sensor out of specification (Hi or low)

ADDITIONAL CHECKS

1. Proper alternator output voltage.
2. Faulty or incorrect thermostat.
3. Throttle linkage sticking, binding, or worn.

DETONATION/SPARK KNOCK

Definition: A mild to severe ping, usually worse under acceleration or heavy load. The engine makes sharp metallic knocks that change with throttle opening.

PRELIMINARY CHECKS

Perform the visual/physical checks as described at the start of “Troubleshooting Charts” section.

CHECK FUEL SYSTEM FOR:

1. Contaminated fuel.
2. Poor fuel quality and proper octane rating.
3. Fuel pressure within specification.

CHECK IGNITION SYSTEM FOR:

1. Proper ignition timing.
2. Proper operation of Knock Sensor (KS) system. Ensure wires are routed **AWAY** from secondary or primary ignition wires.
3. Ignition system ground.
4. Proper heat range and gapped spark plugs.
5. Incorrect knock sensor or knock sensor module.

CHECK SENSORS AND CONTROLS FOR:

1. Engine Coolant temperature (ECT) has shifted value.
2. Binding or sticking Throttle Position (TP) sensor or salt corrosion. Voltage should increase as throttle is moved toward Wide Open Throttle (WOT).

DETONATION/SPARK KNOCK (continued)

CHECK ENGINE FOR:

1. Low oil level.
2. Excessive oil in the combustion chamber. Valve seals for leaking.
3. Perform a compression test.
4. Combustion chambers for excessive carbon build-up. Remove carbon with top engine cleaner.
5. Proper camshaft timing.
6. Incorrect basic engine parts such as cam, heads, pistons, etc.

LACK OF POWER, SLUGGISH OR SPONGY

Definition: Engine delivers less than expected power. Little or no increase in speed when throttle control is moved toward Wide Open Throttle (WOT).

PRELIMINARY CHECKS

Perform the careful visual/physical checks as described at the start of “Troubleshooting Charts” section.

Remove flame arrestor and check for dirt, or for being plugged. Replace as necessary.

CHECK FUEL SYSTEM FOR:

1. Dirty or plugged water separating fuel filter.
2. Contaminated fuel
3. Possible open in injector driver CKTs 467 or 468.
4. Improper fuel pressure.
5. Flooded VST (if equipped)

CHECK IGNITION SYSTEM FOR:

1. Proper initial engine timing.
2. Secondary ignition voltage.
3. Proper operation of Ignition Control (IC)/Knock Sensor (KS),open or short to ground in CKT 423 or 485 will set a DTC 42 or 43.

LACK OF POWER, SLUGGISH OR SPONGY (continued)

CHECK SENSORS AND CONTROLS FOR:

1. Possible open in Engine Coolant Temperature (ECT) and Manifold Absolute Pressure (MAP) sensors (Ground CKT 814). Also could have and set a DTC 14 and/or 33.
2. Throttle Position (TP) sensor circuit if DTC 21 set for open or grounds.
3. Using a scan tool and/or voltmeter record Throttle Position (TP) sensor voltage. It should read less than .7 volt with throttle closed or at idle position. A sticky throttle shaft or binding linkage causes a high voltage
4. Power reduction mode activated.
5. Diagnostic test CKT 451 for being grounded, (maximum RPMs be will lower).

CHECK ENGINE FOR:

1. Restricted exhaust system.
2. Proper cylinder compression.
3. Proper valve timing and worn camshaft.

ADDITIONAL CHECKS:

1. Proper alternator output voltage..
2. Clean, tight and properly located ECM grounds.
3. Excessive resistance on bottom of boat (dirt, barnacles, etc.).
4. Proper size and pitch propeller for application.

CUTS OUT AND MISSES

Definition: Steady pulsation or jerking that follows engine speed, usually more pronounced as engine load increases.

PRELIMINARY CHECKS

Perform the important preliminary checks as described at the start of the “Troubleshooting Charts” section

CHECK IGNITION SYSTEM FOR:

1. Cylinder miss

   a. Start engine, allow engine to stabilize, record RPM, then disconnect IAC motor. Stop engine, ground one spark plug wire at a time. Restart engine and record RPM.

   b. If there is an RPM drop on all cylinders, go to “Stalling, Rough, or Incorrect Idle” section. With engine “OFF” reconnect IAC motor

   c. If there is no RPM drop on one or more cylinders, or excessive variation in RPM drop, check for spark on the suspected cylinder(s).

   d. If there is a spark, remove spark plug(s) in these cylinders and check for: Insulation cracks, insulator cracks,wear, improper gap, burned electrodes, heavy deposits.

   e. Spark plug wire resistance (should not exceed 30,000 ohms).

   f. Faulty ignition coil.

   g. With engine running, spray distributor cap and spark plug wires with a fine mist of water to check for shorts.

CHECK FUEL SYSTEM FOR:

1. Contaminated or restricted water separating fuel filter.

2. Fuel pressure within specification. (Fuel pressure can be checked on fuel rail at the schrader valve. Mechanical pump can be checked with a carburetor fuel pressure gauge downstream from the pump prior to VST.

3. Faulty fuel injectors.

CUTS OUT AND MISSES (continued)

CHECK SENSORS AND CONTROLS FOR:

1. Open or grounds in CKT 417 Throttle Position (TP) sensor signal.
2. Open or grounds in CKT 416 Throttle Position (TP) sensor 5 volt reference.

CHECK ENGINE MECHANICAL FOR:

1. Proper cylinder compression.
2. Bent push rods, worn rocker arms, broken valve springs, worn camshaft lobes. Repair or replace as necessary.

ADDITIONAL CHECKS:

A miss-fire can be caused by Electromagnetic Interference (EMI) on the reference circuit. EMI can usually be detected by monitoring engine RPM with a scan tool or a tachometer. A sudden increase in RPM with little change in actual engine RPM change, indicates EMI is present. If the problem exists, check routing of secondary wires, check ground circuit.

ROUGH, UNSTABLE, OR INCORRECT IDLE, STALLING

Definition: Engine runs unevenly or rough at idle, also the idle may vary in RPM (called hunting). Either condition may be severe enough to cause stalling. Engine idles at incorrect speed.

PRELIMINARY CHECKS

Perform the important preliminary checks as described at the start of"Troubleshooting Charts" section.

CHECK FUEL SYSTEM FOR:

1. Open in CKTs 467 or 468.
2. Fuel injector(s) leaking.

CHECK IGNITION SYSTEM FOR:

1. Correct ignition timing
2. Possible opens in the following circuits, CKTs 424,430 and 423.
3. Possible short to ground in the following circuits, CKTs 430, 424, and 423.
4. Faulty spark plugs, wires, etc.

ROUGH, UNSTABLE, OR INCORRECT IDLE, STALLING (continued)

CHECK SENSORS AND CONTROLS FOR:

1. Proper Idle Air Control (IAC) operation.
2. Possible open the in following circuits for CKTs 410, 417, 416, 813 and 814.
3. Possible short to ground in CKT 417, Throttle Position (TP) sensor signal, CKT 416 Throttle Position (TP) sensor 5 volt reference and CKT 451 diagnostic test circuit.
4. A sticking throttle shaft, binding linkage or salt corrosion will cause a high Throttle Position (TP) sensor voltage (open throttle indication), the ECM will not control idle. Using a scan tool or voltmeter record Throttle Position (TP) sensor voltage. It should read approximately .7 volt closed throttle and approximately 4.5 volts at Wide Open Throttle (WOT).

CHECK ENGINE FOR:

1. Proper cylinder compression.
2. Proper camshaft or weak valve springs

ADDITIONAL CHECKS:

1. Sticking or binding throttle linkage and salt corrosion.
2. Proper alternator output voltage.
3. Battery cables and ground straps should be clean and secure. Erratic voltage will cause Idle Air Control (IAC) to change its position, resulting in poor idle quality.

BACKFIRE (INTAKE)

Definition: Fuel ignites in the manifold, making a loud popping noise.

PRELIMINARY CHECKS

Perform the important preliminary checks as described at the start of “Troubleshooting Charts” section.

CHECK FUEL SYSTEM FOR:

1. An abnormal fuel system condition: If necessary perform fuel system diagnosis.
2. Properly functioning fuel injectors.

CHECK IGNITION SYSTEM FOR:

1. Opens and grounds in CKTs 423, 424 and 430.
2. Proper output voltage of ignition coil.
3. Cross-fire between spark plugs, (distributor cap, spark plug wires and proper routing of plug wires).
4. Faulty or corroded spark plug wires and boots.
5. Faulty spark plugs.
6. Power reduction mode activated. (1996 Models and Older)

CHECK ENGINE FOR:

1. Sticking or leaking valves.
2. Proper valve timing, broken or worn valve train parts.

BACKFIRE (EXHAUST)

Definition: Fuel ignites in the manifold, making a loud popping noise.

PRELIMINARY CHECKS

Perform the important preliminary checks as described at the start of “Troubleshooting” section.

CHECK FUEL SYSTEM FOR:

1. An abnormal fuel system condition: If necessary perform fuel system diagnosis.
2. Proper functioning of fuel injectors.

CHECK IGNITION SYSTEM FOR:

1. Opens and grounds in CKTs 423, 424 and 430.
2. Properly functioning (advancing and retarding of timing) Ignition Control (IC).
3. Proper output voltage of ignition coil.
4. Faulty or corroded spark plug wires and boots.
5. Faulty spark plugs.

CHECK ENGINE FOR:

1. Possible sticking or leaking valves.

DIESELING, RUN-ON

Definition: Engine continues to run after key is turned "OFF," but runs very roughly. If engine runs smoothly, check ignition switch and adjustment.

PRELIMINARY CHECKS

Perform the important preliminary checks as described at the start of"Troubleshooting" section.

CHECK FUEL SYSTEM FOR:

1. Leaking injectors.
2. Flooded VST

CHECK IGNITION SYSTEM FOR:

1. Properly functioning (advancing and retarding of timing) Ignition Control (IC).
2. Correct heat range spark plugs.
3. Proper operation of system relay.

CHECK COOLING SYSTEM FOR:

1. Faulty or incorrect thermostat.
2. Cooling system restriction causing overheating.
3. Loose belts.

POOR FUEL ECONOMY

Definition: Fuel economy is noticeably lower than expected.

PRELIMINARY CHECKS

Perform the important preliminary checks as described at the start of “Troubleshooting” section.

1. Operator’s driving habits.
2. Dirty or plugged flame arrestor.
3. Fuel leaks.

CHECK FUEL SYSTEM FOR:

1. Quality and type of fuel.
2. Flooded VST.
3. Fuel pressure within specification.

CHECK IGNITION SYSTEM FOR:

1. Correct base timing
2. Properly functioning (advancing and retarding of timing) Ignition Control (IC).
3. Fuel fouled, cracked, worn, improperly gapped spark plugs, burned electrodes, or heavy deposits. Repair or replace as necessary.
4. Knock sensor system operation.

POOR FUEL ECONOMY (continued)

CHECK SENSORS AND CONTROLS FOR:

1. If MAP, TP, or Coolant Sensor are erratic there will be poor economy.

CHECK ENGINE FOR:

1. Proper cylinder compression.

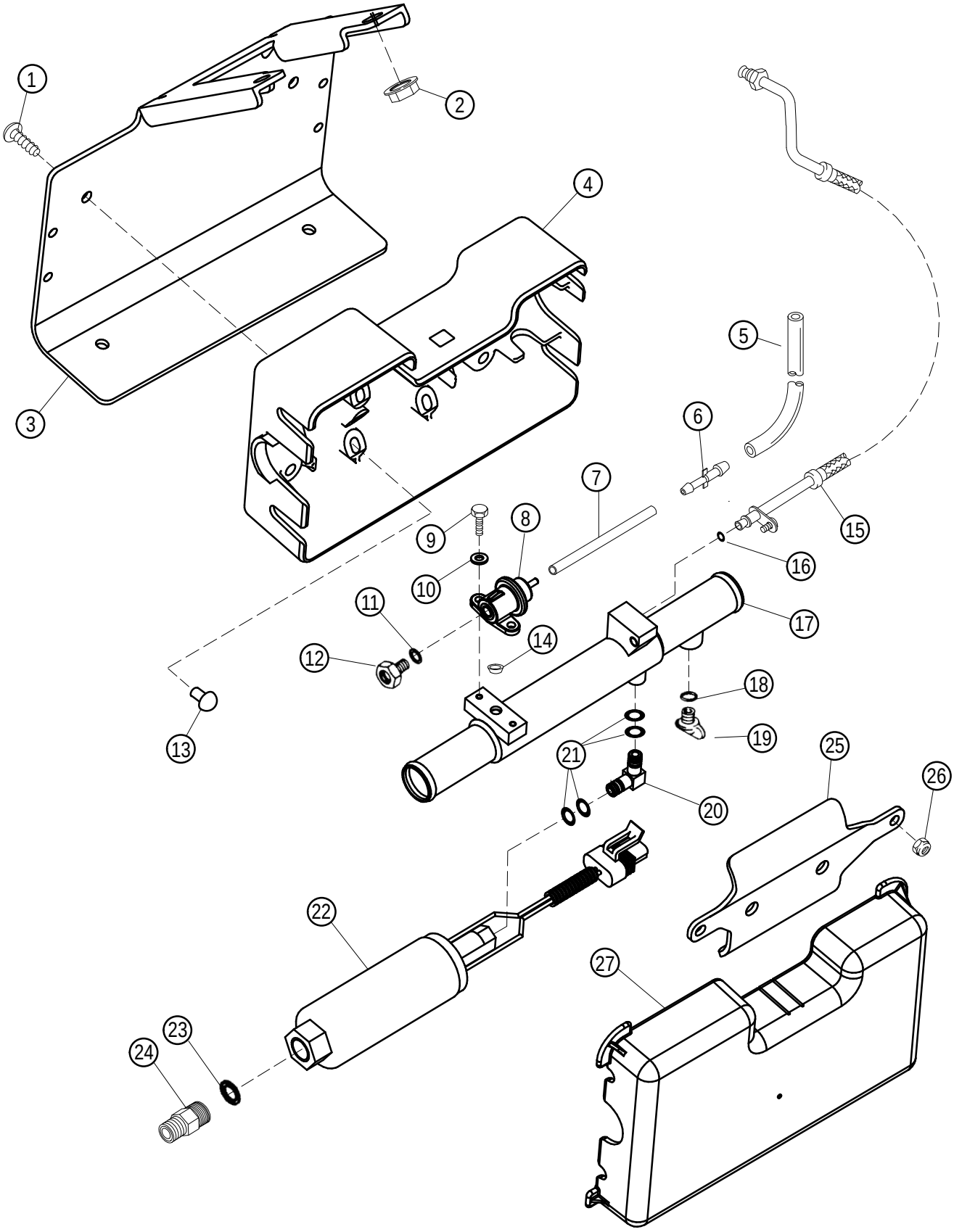
1. Exhaust system restriction.

2. Excessive resistance on bottom of boat (dirt, barnacles, etc.)

3. Proper size and pitch propeller for application.

Fuel Delivery Systems

Cool Fuel System Exploded View



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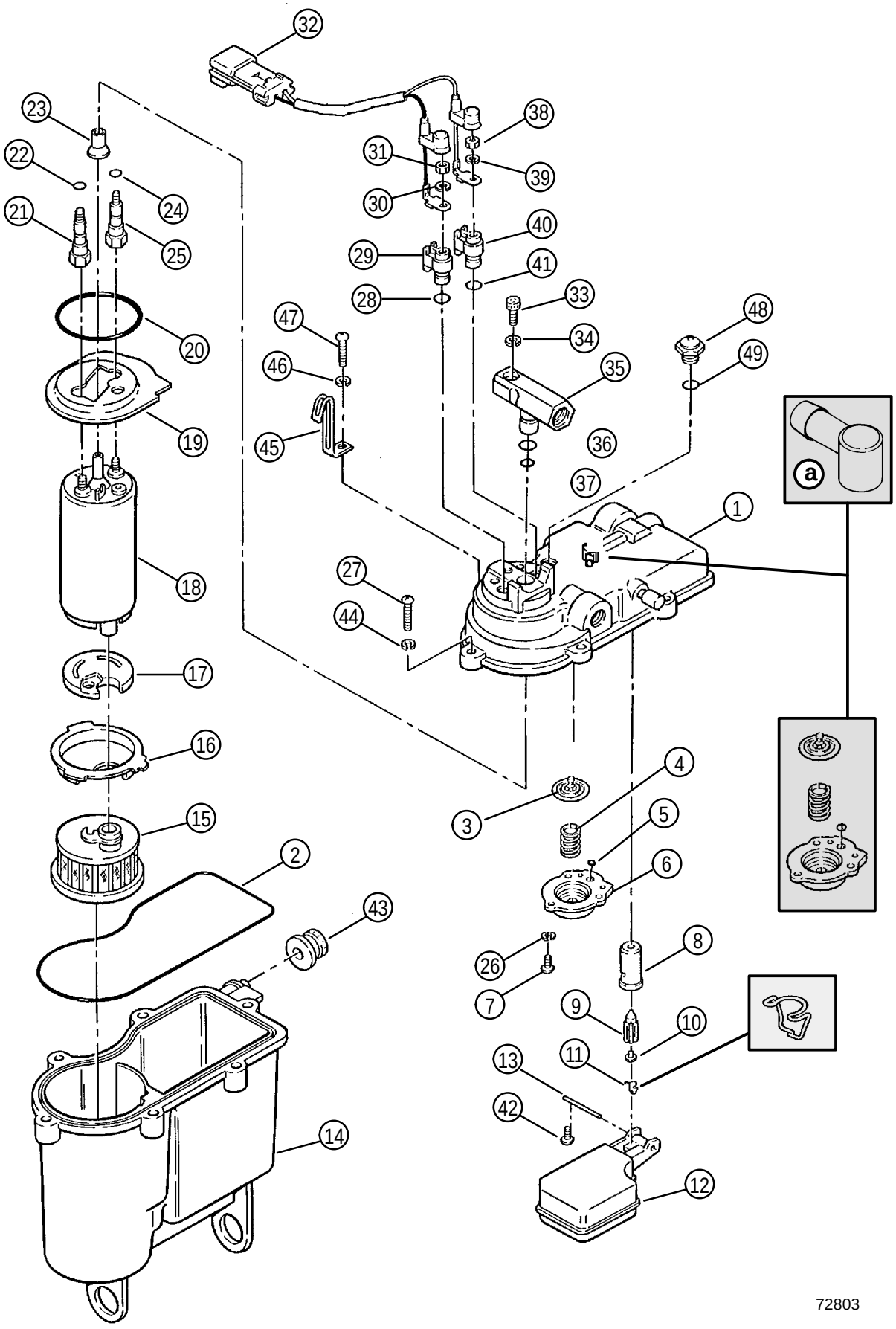
1 -Screws (4)
2 -Nut (2)
3 -Bracket
4 -Cover Base
5 -Reference Line To Plenum Or Flame Arrestor
6 -Fitting
7 -Tubing
8 -Fuel Pressure Regulator
9 -Screw (2)
10-Washer (2)
11-Washer
12-Fuel Return Line Fitting
13-Rubber Bushing (8)
14-Filter
15-Outlet Fuel Line To Fuel Rail Or Throttle Body
16-O-Ring
17-Fuel Cooler
18-O-Ring
19-Drain Plug
20-Elbow Fitting
21-O-Rings (4)
22-Electric Fuel Pump
23-O-Ring
24-Fuel Pump Inlet Fitting
25-Retainer Bracket
26-Nut (2)
27-Cover

Vapor Separator Tank (VST) Exploded View



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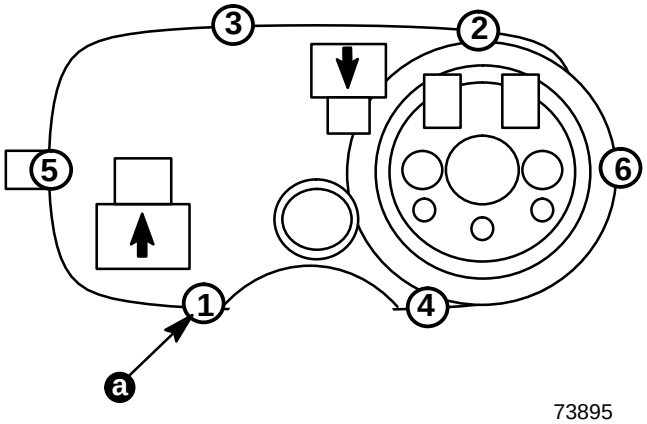
1 -Cover
2 -Seal
3 -Spring
4 -Diaphragm
5 -O-ring
6 -Diaphragm Cover
7 -Screw
8 -Valve Seat
9 -Float Valve
10-Float Valve Pin
11-Clip
12-Float
13-Float Arm Pin
14-VST Body
15-Fuel Screen
16-Plate
17-Rubber Cushion
18-Electric Fuel Pump
19-Plate
20-O-ring
21-Adapter
22-O-ring
23-Collar
24-O-ring
25-Adapter
26-Lockwasher
27-Screw
28-O-ring
29-Insulator
30-Lockwasher
31-Nut
32-Electrical Connector
33-Screw
34-Lockwasher
35-L-Joint
36-O-ring
37-O-ring
38-Nut
39-Lockwasher
40-Insulator
41-O-ring
42-Screw
43-Grommet
44-Lockwasher
45-Clip
46-Lockwasher
47-Screw
48-Plug
49-O-ring

a - A VST equipped with elbow fitting on top of VST will have this configuration diaphragm and spring.

Torque Sequence For VST



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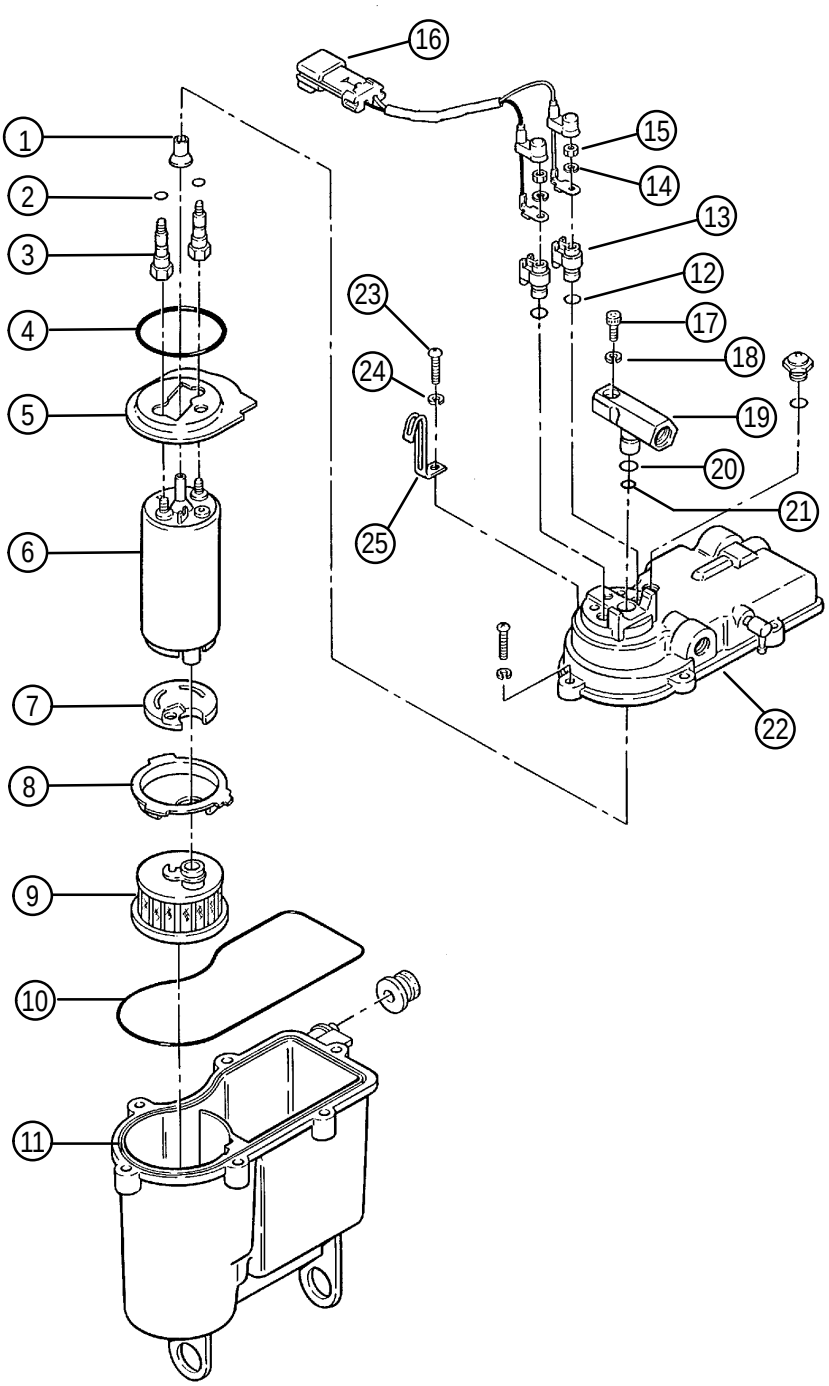
a - Tighten Screws Securely

VST Fuel Pump (Exploded View)



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1 - Collar
2 - O-Rings (2)
3 - Adapters (2)
4 - O-Ring
5 - Plate
6 - Electric Fuel Pump
7 - Rubber Cushion
8 - Plate
9 - Fuel Filter
10- Seal
11- Chamber Body
12- O-Rings (2)
13- Insulators (2)
14- Lockwashers (2)
15- Nuts (2)
16- Electrical Connector
17- Screw
18- Spring Washer
19- L-Joint
20- O-Ring
21- O-Ring
22- Cover
23- Screws (6)
24- Lockwashers (6)
25- Clip

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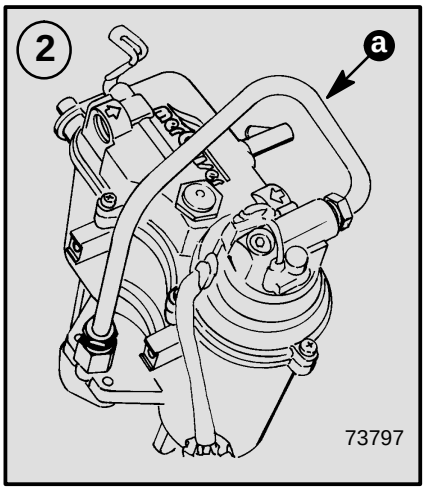
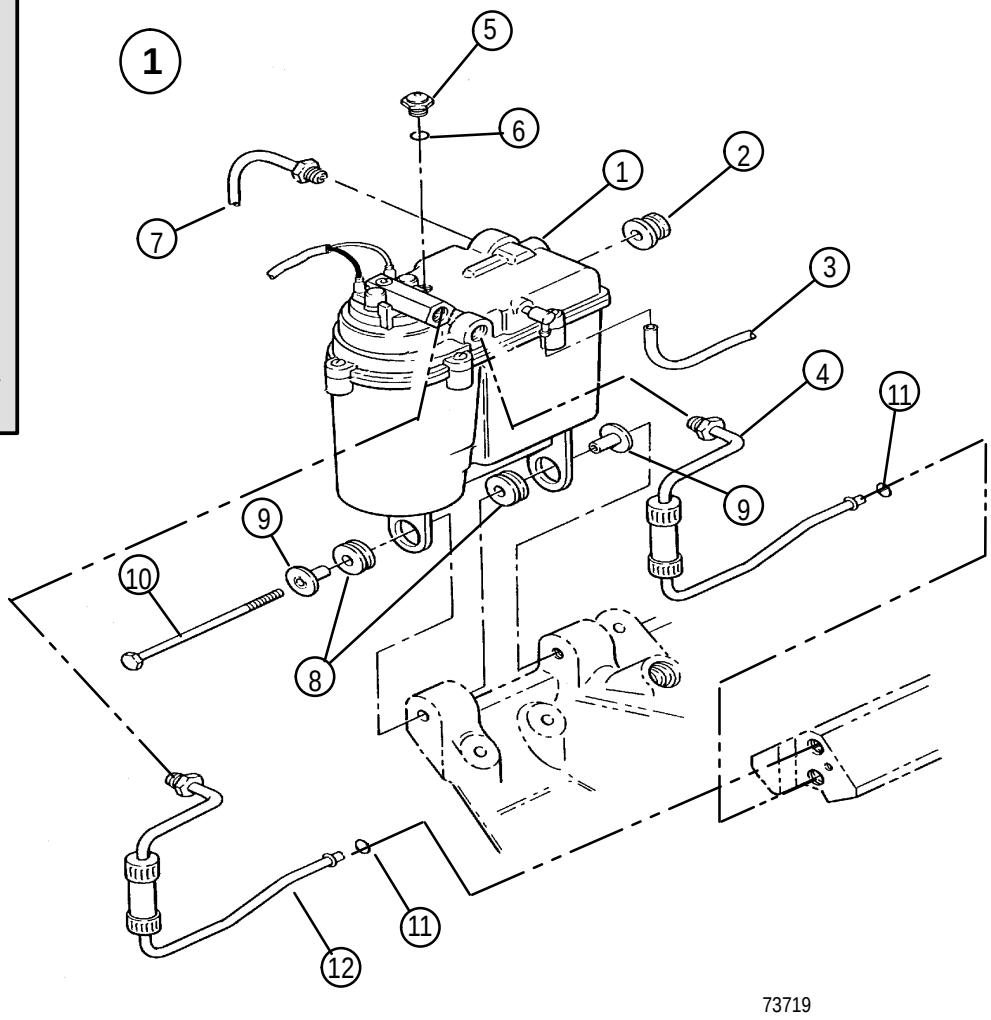
VAPOR SEPARATOR TANK (VST)





NOTE: *Later model VST* ***(MCM 454 Magnum EFI Serial Number-0F130438 and MCM 502 Magnum EFI Serial Number 0F128962 and higher)*** *will be equipped with the fuel line as shown. Earlier VSTs will have fuel lines as shown in figure 2.*

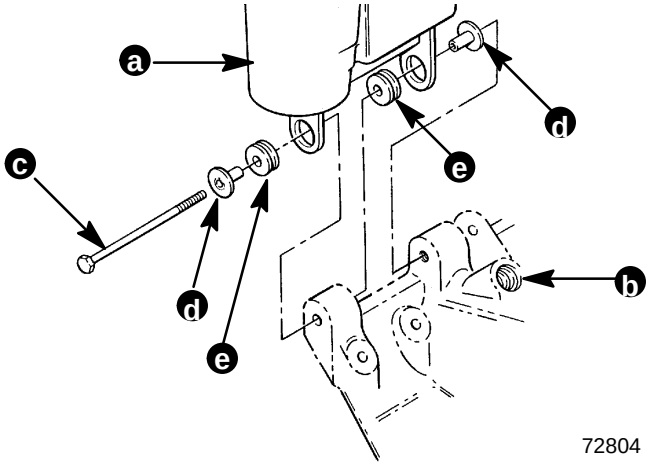
1 - Vapor Separator Tank (VST)
2 - Grommet
3 - Hose
4 - Fuel Line Return
5 - Plug
6 - O-Ring
7 - Fuel Line VST Supply
8 - Grommet
9 - Bushing
10- Screw
11- O-Ring
12- Fuel Line Supply

Vapor Separator Tank (VST)

NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

REMOVAL

1. Disconnect fuel pump electrical connector.
2. Label and then disconnect all fuel lines from cover of vapor separator tank.



a - VST
b - Intake Manifold
c - Screw
d - Bushing
e - Grommet

3. Remove screw and VST from intake manifold.

INSTALLATION

1. Install VST to intake manifold. Apply Loctite 8831 to threads of attaching screw. Torque bolt to 105 lb. in. (12 N·m).
2. Connect all lines to cover of vapor separator tank. Torque fuel line fittings to 23 lb. ft. (31 N·m).
3. Connect fuel pump electrical connector.
4. With engine off, cycle ignition switch to on,waiting 2 seconds and then off, four times waiting 10 seconds after each key off to prime the fuel system and check for leaks.

NOTE: *If VST is dry, remove the vent screw and fill with fuel.*

REMOVAL - VST FUEL PUMP

1. Disconnect fuel pump electrical connector.
2. Label and then disconnect all lines from cover of vapor separator tank.
3. Remove electrical line from retaining clip.
4. Remove screw from L-joint and pull L-joint from cover.
5. Disconnect fuel pump electrical connectors as follows:
   a. Gently pry each side of connector cover up and over retaining tabs.
   b. Remove connector retaining nuts and remove connectors.
6. Remove cover screws and remove cover and electrical line retaining clip.
7. Carefully slide fuel pump assembly from cover.
8. Remove O-ring, plate, adaptors and collar from fuel pump.
9. Remove screen from fuel pump.
10. Remove plate and rubber cushion.

NOTE: *When replacing fuel pump, make certain to replace with a fuel pump of the identical part number.*

INSTALLATION

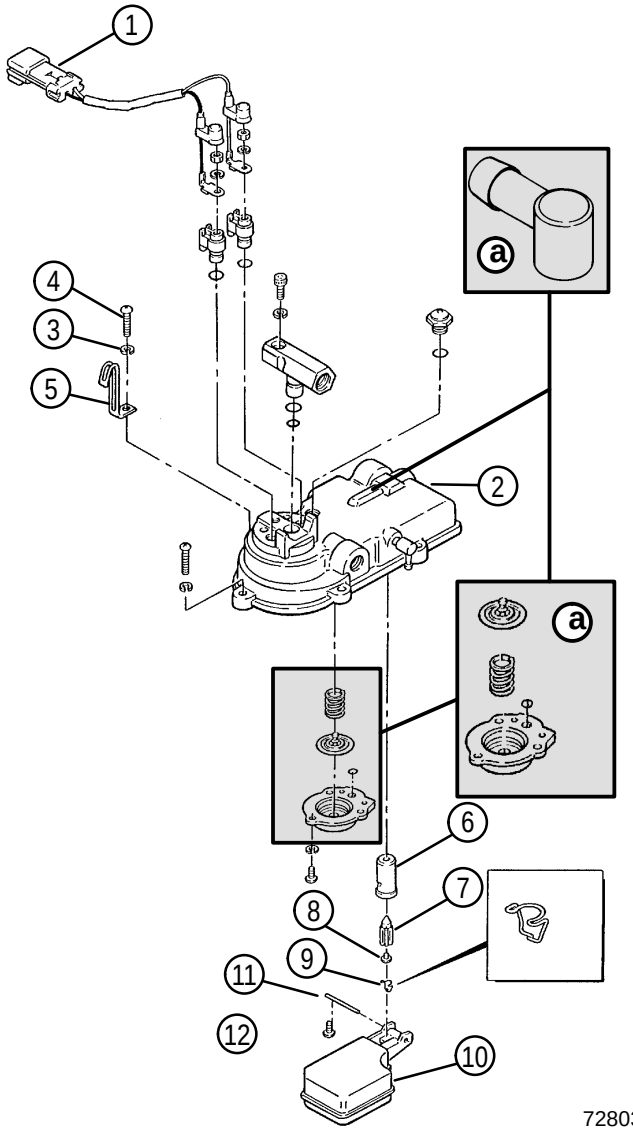
1. Install rubber cushion and plate, making sure to align cutout in plate with pump inlet.
2. Install screen on fuel pump.
3. Install adaptors, collar, plate and new O-ring on fuel pump. Be sure that fuel pump relief valve fits through hole in plate.
4. Slide fuel pump into cover.
5. Apply Loctite Type 8831 to threads of cover screws. Install cover and electrical line retainer clip and tighten cover screws securely.
6. Connect fuel pump electrical connectors. Snap connector covers in place. Secure electrical line in retainer clip.
7. Install L-joint onto cover. Tighten screw securely.
8. Connect all fuel lines to cover of vapor separator tank. Torque fuel line fittings to 23 lb. ft. (31 N·m).
9. Connect fuel pump electrical connector.
10. With engine OFF, cycle ignition switch to ON, wait 2 seconds and then OFF, four times waiting 10 seconds after each key off to prime the fuel system and check for leaks.

NOTE: *If VST is dry, remove the vent screw and fill with fuel.*

Float and Needle Assembly

REMOVAL

1. Disconnect fuel pump electrical connector. (Electric fuel pump removed for visual clarity.)



a - A VST equipped with elbow fitting on top of VST will have this configuration diaphragm and spring.

1 - Electrical Connector
2 - Cover
3 - Lockwashers (6)
4 - Screws (6)
5 - Clip
6 - Valve Seat
7 - Float Valve
8 - Float Valve Pin
9 - Clip
10- Float
11- Float Arm Pin
12- Screw

2. Label and then disconnect all fuel lines from cover of vapor separator tank.
3. Remove electrical line from retaining clip. (some models)
4. Remove cover screws and remove cover and electrical line retainer clip.
5. Remove float arm pin retaining fastener and remove float and needle assembly.
6. Disassemble float and needle assembly; i.e., float valve, float valve pin, clip and float.

CLEANING AND INSPECTION

1. Clean components with carburetor cleaner.

IMPORTANT: Do not soak float or float valve in carburetor cleaner.

2. Inspect float valve seat for wear. Replace if necessary.
3. Inspect float and needle assembly; i.e., float valve, float valve pin, clip and float. Replace parts as necessary.

INSTALLATION

1. Assemble float and needle assembly; i.e., float valve, float valve pin, clip and float.

NOTE: *Float is not adjustable.*

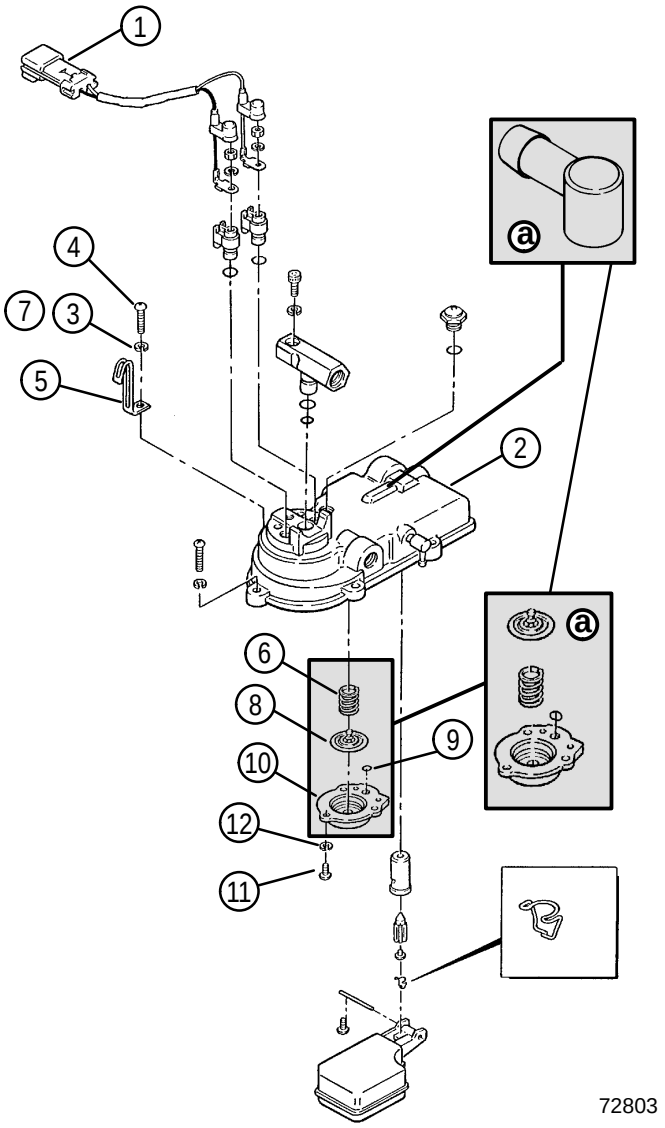
2. Install float and needle assembly and secure float arm pin using fastener.
3. Apply Loctite 8831 to threads of cover screws. Install cover and electrical line retainer clip and tighten cover screws securely.
4. Secure electrical line in retainer clip.
5. Connect all fuel lines to cover of vapor separator tank. Torque fuel line fittings to 23 lb. ft. (31 N·m).
6. Connect fuel pump electrical connector.
7. With engine OFF, cycle ignition switch to ON waiting for 2 seconds, and then OFF, waiting 10 seconds after each key off four times to prime the fuel system and check for leaks.

NOTE: *IF VST is dry. remove vent screw and fill with fuel.*

Diaphragm Assembly

REMOVAL

1. Disconnect fuel pump electrical connector. (Electric fuel pump removed for visual clarity.)



a - A VST equipped with elbow fitting on top of VST will have this configuration diaphragm and spring.

1 - Electrical Connector
2 - Cover
3 - Lockwashers (6)
4 - Screws (6)
5 - Clip
6 - Spring
7 - Diaphragm
8 - O-Ring
9 - Diaphragm Cover
10- O-Ring
11- Screw
12- Lockwasher

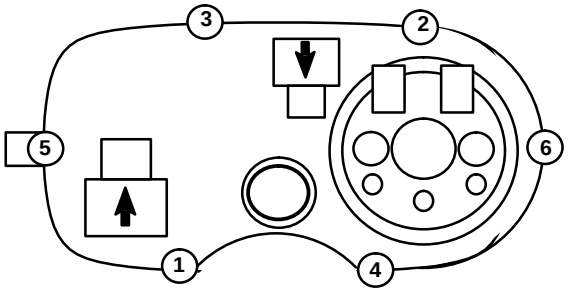
2. Label and then disconnect all fuel lines from cover of vapor separator tank.
3. Remove electrical line from retainer clip.
4. Remove cover screws and remove cover and electrical line retaining clip.
5. Remove float arm pin retaining fastener and remove float and needle assembly.
6. Remove diaphragm cover screws and remove diaphragm cover, O-ring, diaphragm and spring.

CLEANING AND INSPECTION

7. Clean and inspect all parts. Check diaphragm for damage. Replace if necessary.
8. Inspect spring for wear. Replace if necessary.

INSTALLATION

1. Install spring, diaphragm, O-ring and diaphragm cover using diaphragm cover screws. Tighten screws.
2. Install float and needle assembly and secure float arm pin using fastener.
3. Apply Loctite 8831 to threads of cover screws. Install cover and electrical line retainer clip and tighten cover screws securely.



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Torque Sequence For VST

4. Secure electrical line in retainer clip.
5. Connect all fuel lines to cover of vapor separator tank. Torque fuel line fittings to 23 lb. ft. (31 N·m).
6. Connect fuel pump electrical connector.
7. With engine OFF, cycle ignition switch to ON,wait for 2 seconds, then OFF, four times, waiting 10 seconds after each key off to prime the fuel system and check for leaks.

Throttle Body Injection Repair Procedures

⚠WARNING

Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S Coast Guard Rules and Regulations to minimize risks of fire and explosion. Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

Special Tools

Description	Part Number
Fuel Pressure Gauge	91-168850A1

Lubricants/Sealants/ Adhesives

Description	Part Number
Loctite 8831	92-823089-1
Loctite 262	Obtain Locally
Loctite 242	

Torque Specifications

Fastener Location	Lb. In.	Lb. Ft.	N•m
Flame Arrestor To Throttle Body		50	6
Throttle Body To Adapter		30	40
Adapter To Intake Manifold			
Intake Manifold To Heads		25	34
VST Cover To Body		6	8
Spark Plugs		11	15
VST To Throttle Body		23	31
Sensors And Plugs To Thermostat Housing	Hand Tight Plus 2-1/2 Turns Maximum		
Knock Sensor		14	19
TP Sensor	20		2
IAC Valve		13	18
Distributor Hold-Down Clamp		30	40
MAP Sensor	53		6

Throttle Body Injection System Description

The fuel system consists of a fuel supply, tank, water separating fuel filter, electric fuel pump, pressure regulator, fuel injectors, throttle body and throttle position (TP) sensor.

Fuel is drawn from the boat's fuel supply tank, through a water separating fuel filter and fuel cooler, by a electrical fuel pump.

A pressure regulator located on the fuel cooler maintains a constant fuel pressure. The fuel bled off from the pressure regulator is delivered back to the water separating fuel filter.

The throttle body is the component of the system which supplies the air required for optimum fuel combustion. The throttle body consists of a housing, two injectors, two throttle plates, throttle plate linkage, idle air control (IAC) valve and throttle position (TP) sensor.

Service Precautions

⚠WARNING

Always disconnect battery cables from battery BEFORE working on fuel system to prevent fire or explosion.

⚠WARNING

Be careful when cleaning flame arrestor and crankcase ventilation hoses; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark or open flame in area when cleaning flame arrestor and crankcase ventilation hoses.

⚠WARNING

Be careful when changing fuel system components; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark or open flame in the area while changing fuel filter(s). Wipe up any spilled fuel immediately.

⚠WARNING

Be sure that the engine compartment is well ventilated and that no gasoline vapors are present to avoid the possibility of fire.

⚠WARNING

Make sure no fuel leaks exist before closing engine hatch.

⚠CAUTION

Fuel pressure MUST BE relieved before servicing any component in the fuel system.

⚠CAUTION

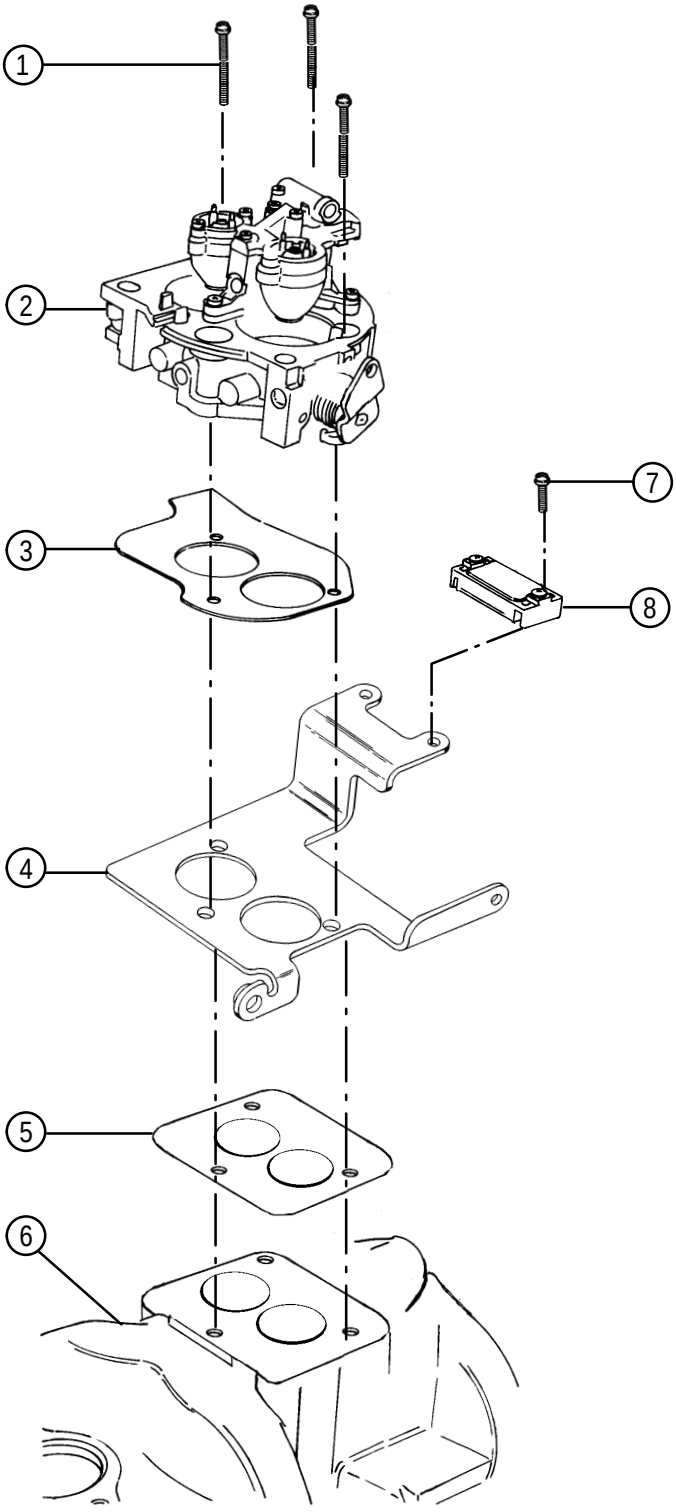
DO NOT operate engine without cooling water being supplied to seawater pump or water pump impeller will be damaged and subsequent overheating damage to engine may result.

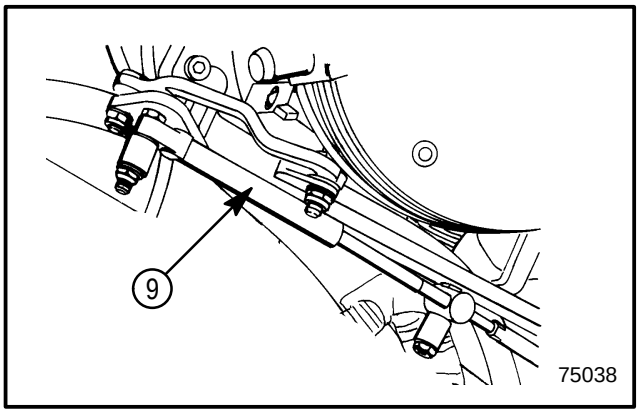
The following information MUST BE adhered to when working on the fuel system:

- **Always keep a dry chemical fire extinguisher at the work area.**
- **Always install new O-rings when assembling fuel system parts.**
- **DO NOT replace fuel pipe with fuel hose.**
- **Always relieve system fuel pressure prior to servicing any component in the fuel system.**
- **DO NOT attempt any repair to the fuel system until instructions and illustrations relating to that repair are thoroughly understood.**
- **Observe all Notes and Cautions.**

Throttle Body Exploded Views

Induction System





1 - Screws (3)
2 - Throttle Body Unit
3 - Gasket
4 - Throttle Body Adapter Plate
5 - Gasket
6 - Intake Manifold
7 - Screws (2)
8 - Manifold Absolute Pressure (MAP) Sensor
9 - Throttle Linkage

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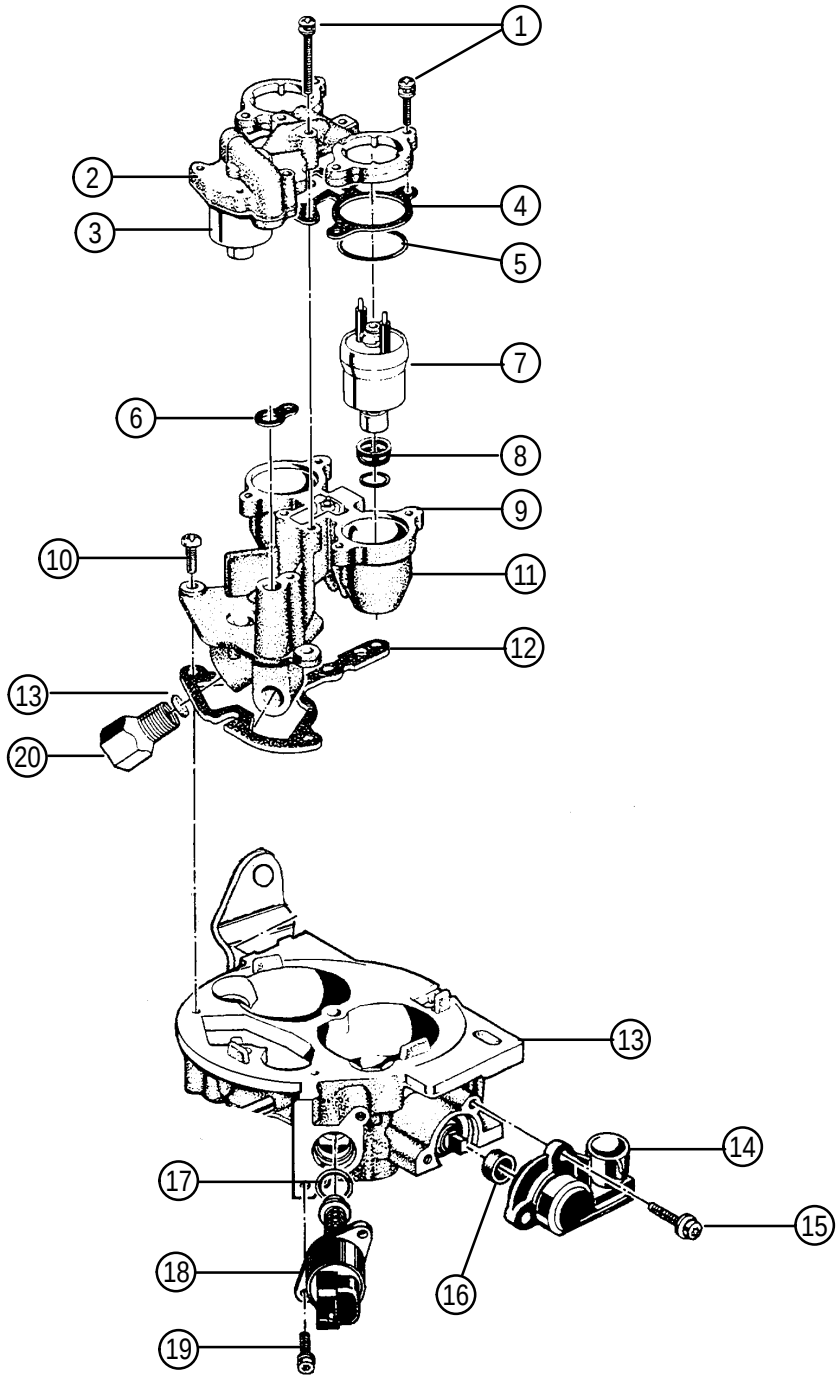
Throttle Body



1 - Cap Screw
2 - Cover Assembly
3 - Fuel Pressure Regulator
4 - Cover Assembly Gasket
5 - Upper O-Ring
6 - Fuel Meter Outlet Gasket
7 - Fuel Injector (2)
8 - Fuel Filter (2)
9 - Lower O-Ring
10- Screw
11- Body
12- Throttle Body To Fuel Meter Body Gasket
13- Throttle Body
14- Throttle Position (TP) Sensor
15- Screws (2)
16- Seal
17- O-Ring
18- Idle Air Control (IAC) Valve
19- Screws (2)
20- Fuel Inlet

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Fuel Pressure Relief Procedure

NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

1. Disconnect electrical connector from fuel pump.
2. Crank engine for ten seconds (if engine starts allow it to run until it dies) to relieve any fuel pressure in the system.

Fuel Meter Cover Assembly

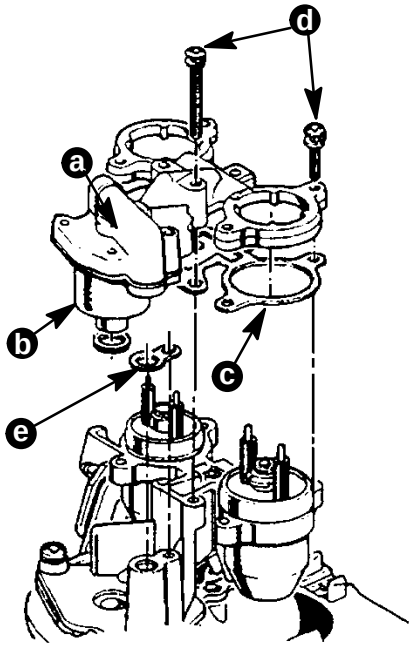
NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

⚠CAUTION

DO NOT remove the four screws securing the pressure regulator to the fuel meter cover. The fuel pressure regulator includes a large spring under heavy compression which, if accidentally released, could cause personal injury.

REMOVAL

1. Remove the flame arrestor from the throttle body.
2. Disconnect electrical connectors to fuel injectors. (Squeeze plastic tabs and pull straight up.)
3. Remove the fuel meter cover screw assemblies.
4. Remove fuel meter cover assembly.



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a - Fuel Meter Cover
b - Fuel Damper
c - Gaskets (Regulator Passages)
d - Screws
e - Fuel Meter Outlet Gasket

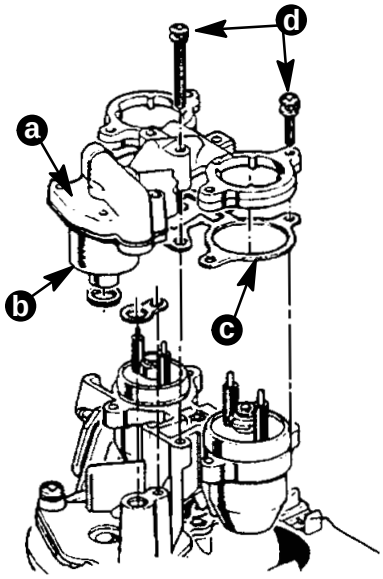
CLEANING AND INSPECTION

IMPORTANT: DO NOT immerse the fuel meter cover (with pressure regulator) in cleaner, as damage to the regulator diaphragm and gasket could occur.

1. Inspect pressure regulator seating area for pitting, nicks, burrs or irregularities. Use a magnifying glass if necessary. If any of the above is present, replace the cover assembly.

INSTALLATION

1. Install new pressure regulator seal, fuel meter outlet passage gasket, and cover gasket.
2. Install fuel meter cover assembly.
3. Install attaching screws, precoated with appropriate locking compound to threads. (Short screws are next to injectors.)
4. Torque screws to 28 lb. in. (3 N·m).
5. Connect electrical connectors to fuel injectors.
6. With engine “OFF,” and ignition “ON,” check for leaks around gasket and fuel line couplings.



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a - Fuel Meter Cover
b - Pressure Regulator Assembly
c - Gaskets (Regulator Passages)
d - Screws

Fuel Injectors

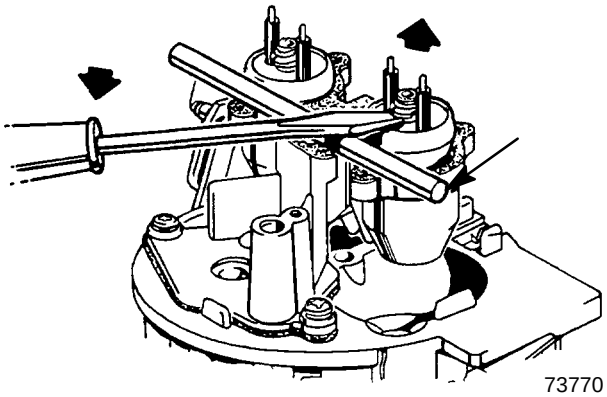
NOTICE
Refer to “Service Precautions,” in “Repair Procedures,” BEFORE proceeding.

REMOVAL

NOTE: *Use care in removing fuel injectors to prevent damage to the electrical connector and nozzle.*

IMPORTANT: The fuel injector is an electrical component. DO NOT soak in any liquid cleaner or solvent, as damage may result.

1. Remove flame arrestor and fuel meter cover as outlined in this section.
2. Using a screwdriver carefully pry up on fuel injector to remove it from the fuel meter body (Use a screwdriver or rod under the the screwdriver when prying up. Leave old gasket in place to prevent damage to fuel meter body).

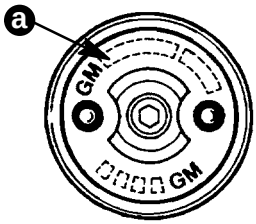


73770

CLEANING AND INSPECTION

Inspect fuel injectors for damage; replace if necessary.

IMPORTANT: When replacing injectors, be certain to replace with the identical part and part number. Other injectors may have the same appearance, yet have a different part number and be calibrated for a different flow rate, and if installed, would cause performance difficulty or damage to the ECM.

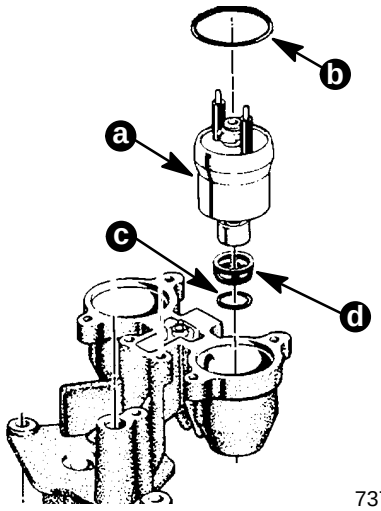


73772

a - Part Indentification Number

INSTALLATION

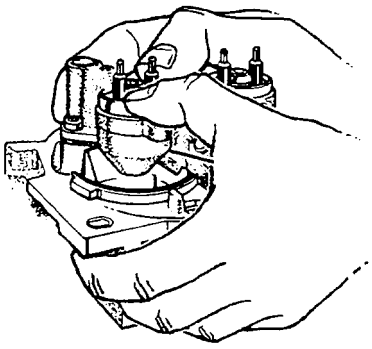
1. Install new lower O-rings on fuel injectors. Lubricate O-rings using a water soap solution.



73766

a - Fuel Injector
b - Upper O-Ring
c - Lower O-Ring
d - Fuel Filter

2. Install upper O-rings in fuel meter body. Lubricate O-rings with water soap solution.
3. Install fuel injectors into the fuel meter body. Align the raised lug on the injector base with the notch in fuel meter cavity.



73771

NOTE: *The electrical terminals of the injectors should be parallel with throttle shaft.*

4. Install gasket and fuel meter cover, torque screws to 28 in. lb. (3.0 N·m) and flame arrestor as outlined in this section.
5. Connect electrical connections to fuel injectors.
6. With engine “OFF,” and ignition “ON,” check for leaks around gasket and fuel line couplings

Throttle Body

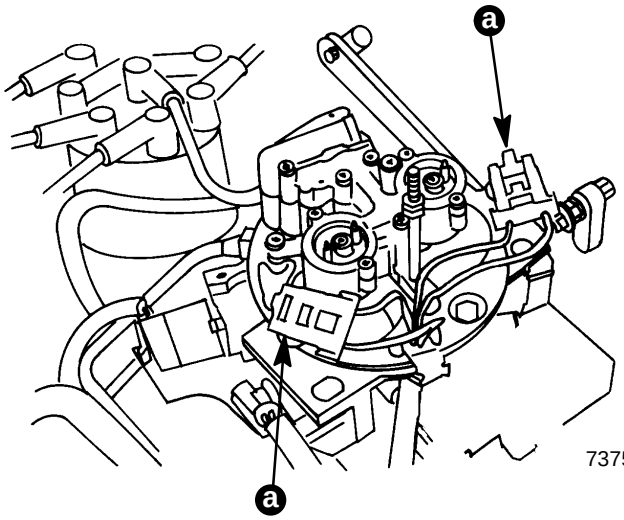
REMOVAL

⚠CAUTION

Ensure that fuel pressure is relieved before removing the fuel inlet and return lines.

IMPORTANT: DO NOT allow the TP sensor, fuel pressure regulator, fuel injectors and IAC valve to come into contact with solvent or cleaner. These components should be removed prior to immersion in solvent.

1. Remove the flame arrestor from the throttle body.
2. Disconnect throttle cable.
3. Disconnect the electrical connections from the TP sensor, IAC and fuel injectors. (Squeeze plastic tabs on injectors and pull straight up).



73750

a - Electrical Connections

4. Remove fuel inlet and outlet lines from throttle body.
5. Remove screws retaining the throttle body to adapter plate.

NOTE: *Place a shop rag over the intake manifold opening to prevent debris from entering intake manifold.*

CLEANING AND INSPECTION

1. Thoroughly clean metal parts of throttle body in a cold immersion type cleaner. Dry with compressed air. Make certain that all passages are free of dirt and burrs.
2. Inspect mating surfaces for damage that could affect gasket sealing.
3. Inspect throttle body for cracks in casting.
4. Inspect throttle plates, linkage, return springs, etc., for damage, wear and foreign material.
5. Check intake manifold plenum for loose parts and foreign material.

INSTALLATION

1. Install fuel injectors and fuel meter body as previously described in this section.
2. Install a new gasket on adapter plate.
3. Install throttle body on adapter plate and torque the screws. 30 ft. lb. (40 N·m).
4. Connect throttle linkage to throttle body.
5. Move throttle from idle to WOT and check that the throttle movement is not binding.
6. Connect the fuel inlet and return lines. Torque to 23 ft. lb. (31 N·m).
7. Connect TP sensor, IAC, and fuel injectors connections.
8. Turn key to on position and check for fuel leaks around the inlet and return line connections.
9. Start engine and check for fuel leaks.

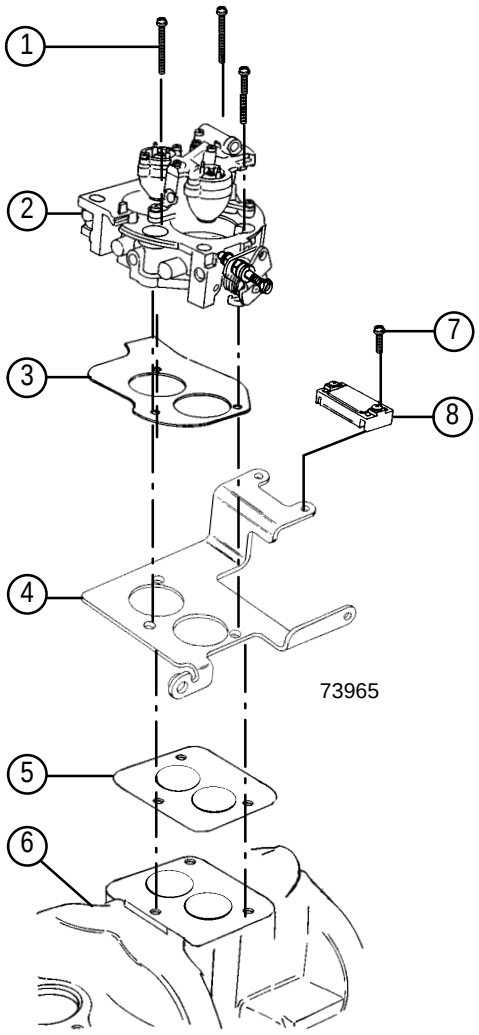
Throttle Body Adapter Plate

NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

REMOVAL

IMPORTANT: Place a clean shop towel over the intake manifold opening to prevent foreign material from entering the engine.

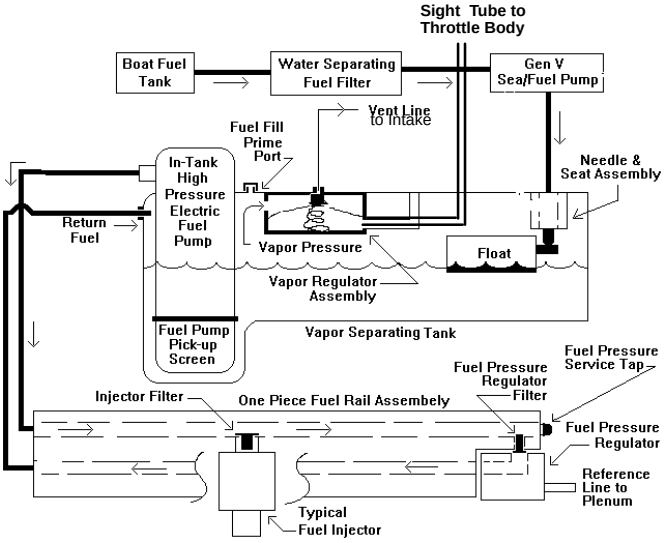
1. Remove flame arrestor.
2. Remove throttle body refer to Throttle Body Section.
3. Remove screws and the throttle body adapter from the intake manifold.



1 - Screws (3)
2 - Throttle Body Unit
3 - Gasket
4 - Throttle Body Adapter Plate
5 - Gasket
6 - Intake Manifold
7 - Screws (2)
8 - Manifold Absolute Pressure (MAP) Sensor

Multi-Port System Description

The MerCruiser EFI Fuel System consists of a fuel supply, water separating fuel filter, mechanical fuel pump, vapor separator tank (VST), electric fuel pump, injector fuel filter, fuel rail, pressure regulator, fuel injectors, throttle body and throttle position (TP) sensor.



Fuel is drawn from the boat's fuel supply (tank), through a water separating fuel filter, by a mechanical fuel pump mounted on and driven by a seawater pump, and is delivered to the vapor separator tank (VST).

The VST consists of a reservoir, float, needle and seat assembly, fuel pump pickup screen, electric fuel pump. The electric fuel pump located in the VST, pumps the fuel rail supplying pressurized fuel to the fuel injectors.

A pressure regulator located on the fuel rail maintains a constant fuel pressure in the fuel rail. The fuel bled off from the pressure regulator is delivered back to the VST.

The throttle body is the component of the system which supplies the air required for optimum fuel combustion. The throttle body consists of a housing, two throttle plates, throttle plate linkage, idle air control (IAC) valve and throttle position (TP) sensor.

Service Precautions

⚠WARNING

Always disconnect battery cables from battery BEFORE working on fuel system to prevent fire or explosion.

⚠WARNING

Be careful when cleaning flame arrestor and crankcase ventilation hose; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark or open flame in area when cleaning flame arrestor and crankcase ventilation hose.

⚠WARNING

Be careful when changing fuel system components; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark or open flame in the area while changing fuel filter(s). Wipe up any spilled fuel immediately.

⚠WARNING

Be sure that the engine compartment is well ventilated and that no gasoline vapors are present to avoid the possibility of fire.

⚠WARNING

Make sure no fuel leaks exist, before closing engine hatch.

⚠CAUTION

Fuel pressure MUST BE relieved before servicing high pressure component in the fuel system.

⚠CAUTION

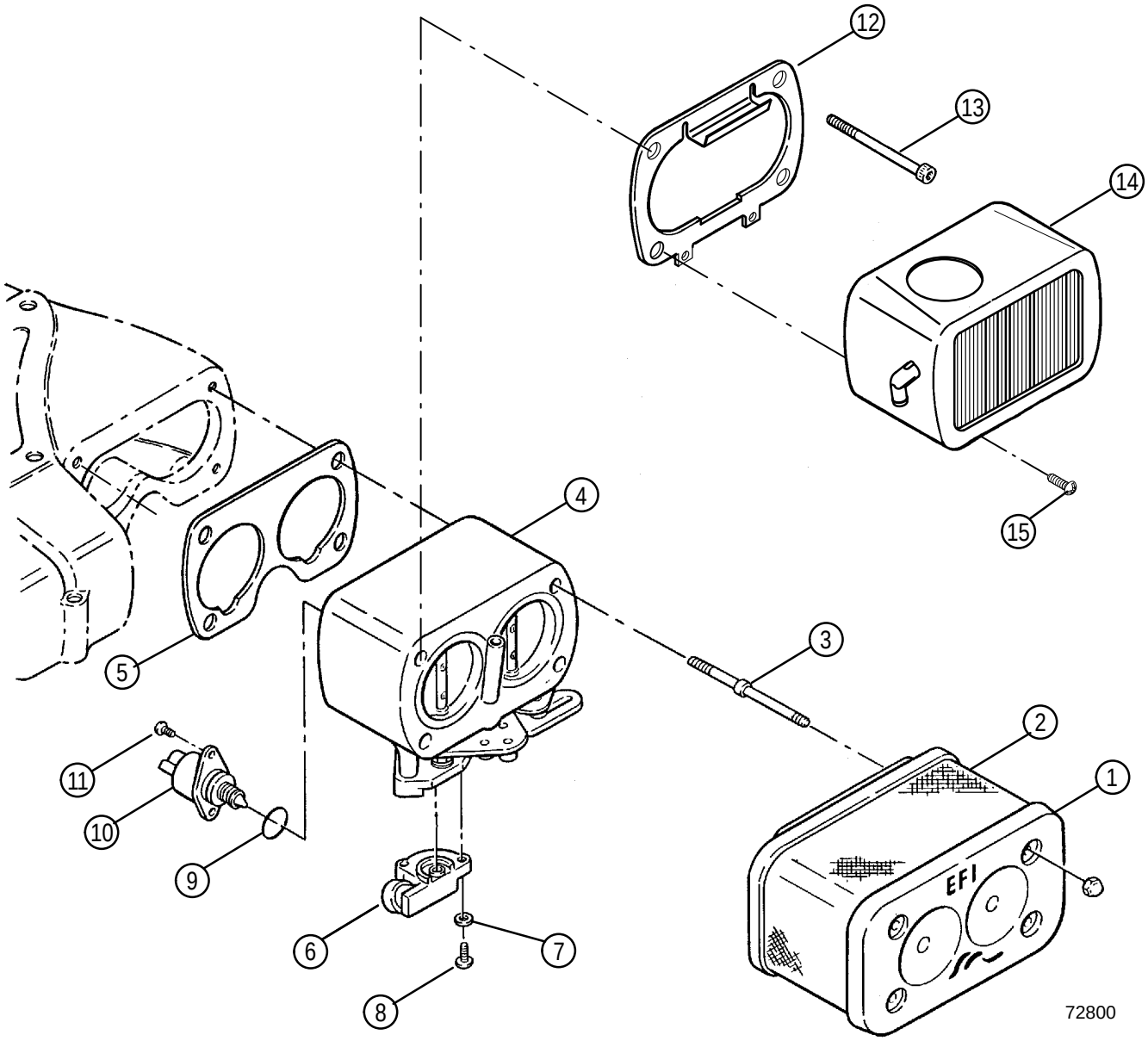
DO NOT operate engine without cooling water being supplied to water pickup holes in gear housing, or water pump impeller will be damaged and subsequent overheating damage to engine may result.

The following information MUST BE adhered to when working on the fuel system:

- **Always keep a dry chemical fire extinguisher at the work area.**
- **Always install new O-rings when assembling fuel pipe fittings.**
- **DO NOT replace fuel pipe with fuel hose.**
- **DO NOT attempt any repair to the fuel system until instructions and illustrations relating to that repair are thoroughly understood.**
- **Observe all Notes and Cautions.**

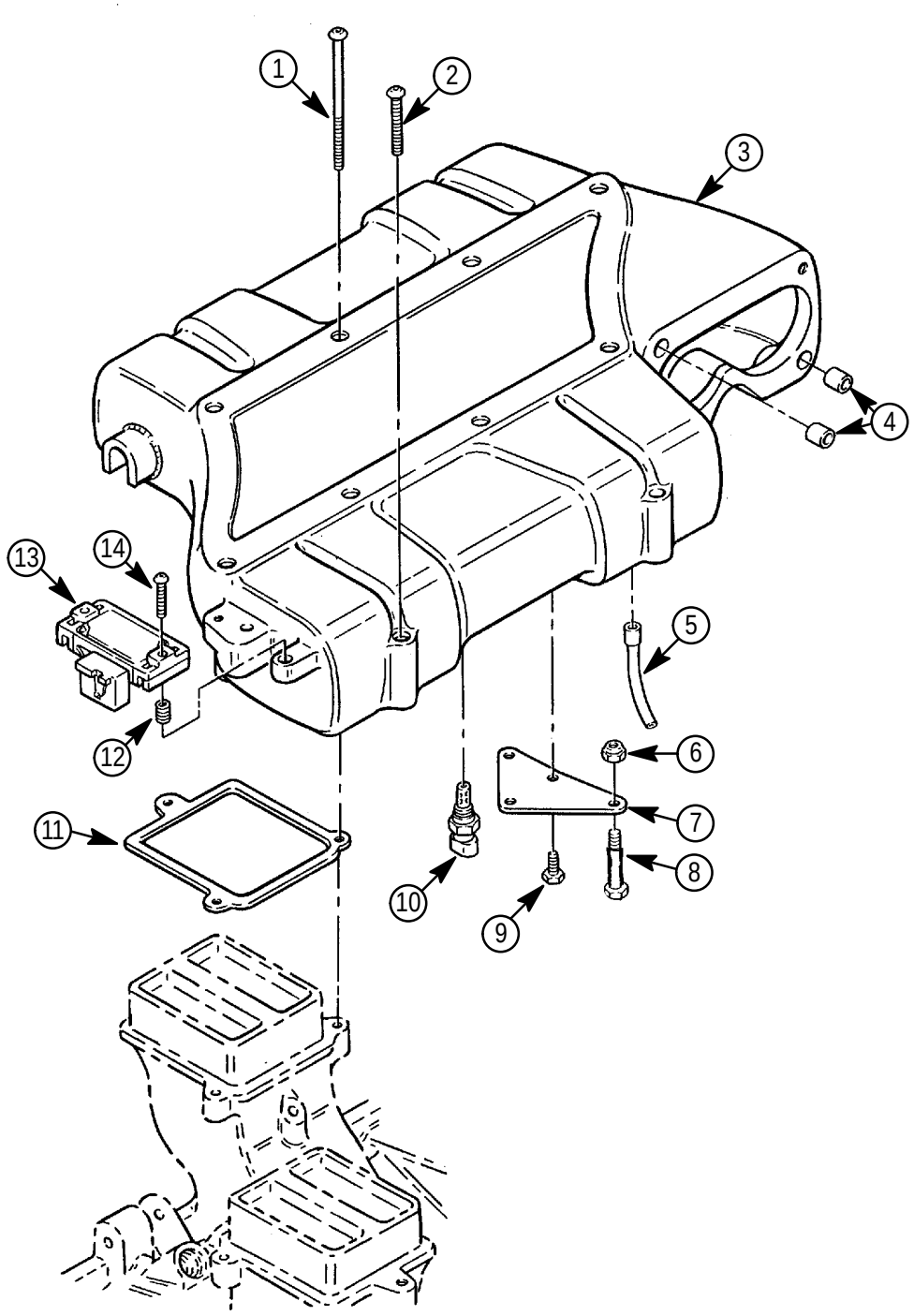
Multi-Port Exploded Views

Flame Arrestor and Throttle Body



1 - Cap Nut
2 - Flame Arrestor
3 - Stud
4 - Throttle Body
5 - Gasket
6 - Throttle Position (TP) Sensor
7 - Washer
8 - Screw
9 - O-Ring
10- Idle Air Control (IAC) Valve
11- Screw
12- Mounting Bracket (1997 and Newer Models)
13- Screw (1997 and Newer Models)
14- Flame Arrestor (1997 and Newer Models)
15- Screw (1997 and Newer Models)

Plenum



72802

1 - Screw
2 - Screw
3 - Plenum
4 - Sleeve
5 - Drain Line To Intake
6 - Nut
7 - Bracket
8 - Stud
9 - Screw
10- Intake Air Temperature (IAT) Sensor
11- Gasket
12- Seal
13- Manifold Absolute Pressure (MAP) Sensor
14- Screw

Index

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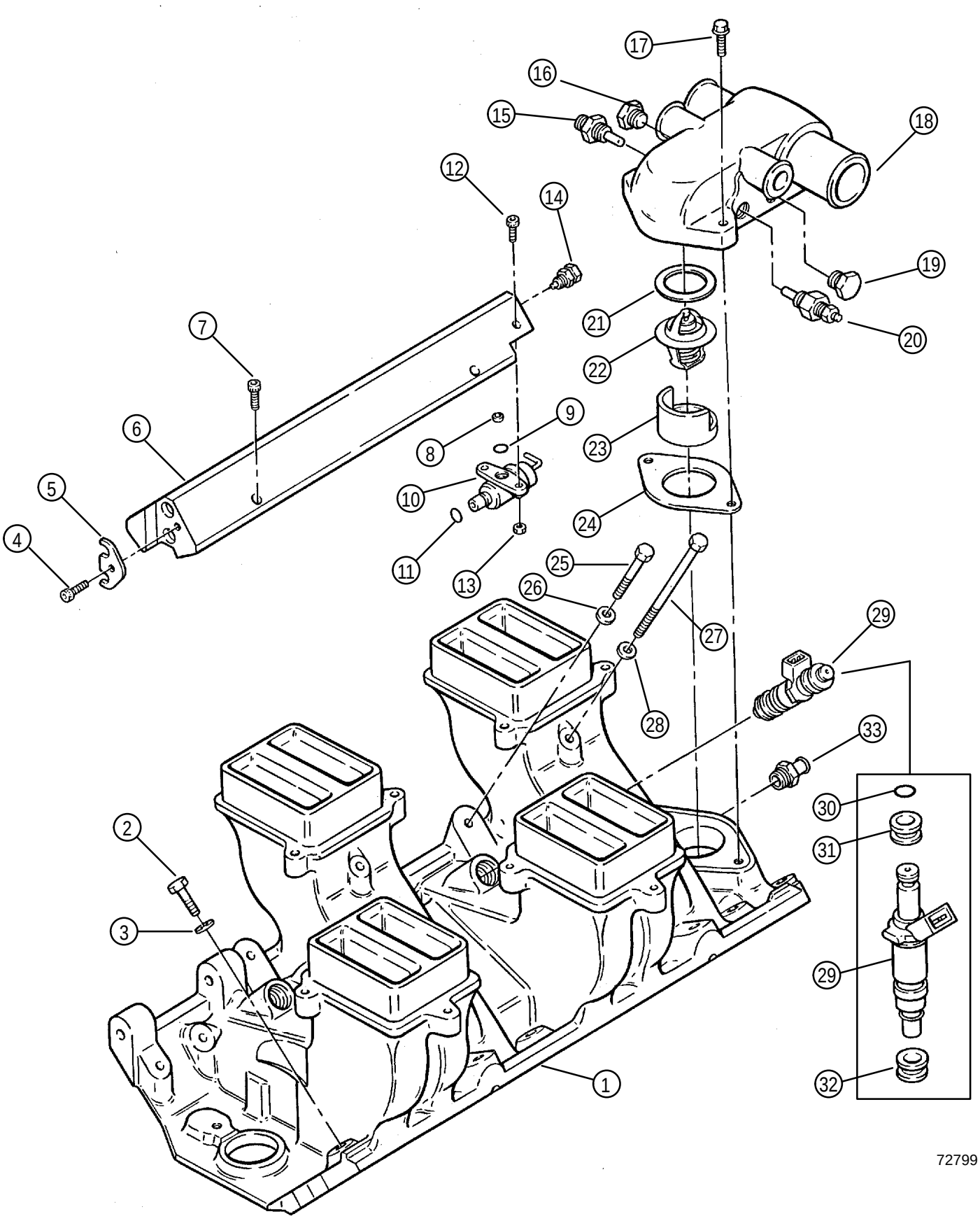
Intake Manifold and Fuel Rail



Index

1 -Intake Manifold
2 -Bolt
3 -Washer
4 -Bolt
5 -Retainer
6 -Fuel Rail
7 -Bolt
8 -Filter
9 -O-Ring
10-Pressure Regulator (VST Models) Or Fuel Damper (Cool Fuel Models)
11-O-Ring
12-Screw
13-Nut
14-Schrader Valve
15-Engine Coolant Temperature (ECT) Sensor
16-Plug
17-Bolt
18-Thermostat Housing
19-Plug
20-Water Temperature Sender
21-Gasket
22-Thermostat
23-Sleeve
24-Gasket
25-Bolt
26-Washer
27-Bolt
28-Washer
29-Fuel Injector
30-O-Ring
31-Grommet
32-Grommet
33-Fitting

Fuel Pressure Relief Procedure

NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

1. Disconnect electrical connector at fuel pump.
2. Crank engine for ten seconds (if engine starts allow it run until it dies) to relieve any fuel pressure in the system.

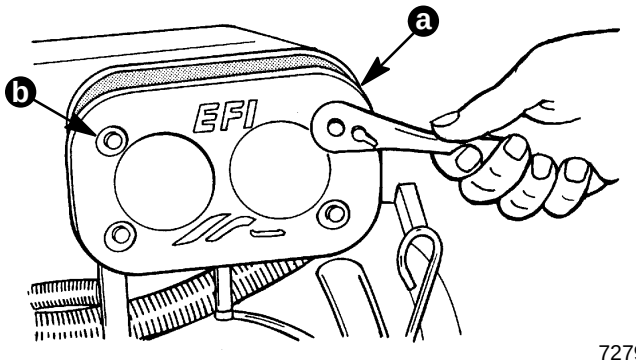
Multi-Port Components

Flame Arrestor

NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

REMOVAL

Remove four flame arrestor mounting cap nuts and remove flame arrestor from throttle body.



72790

a - Flame Arrestor
b - Cap Nuts (4)

CLEANING AND INSPECTION

Clean flame arrestor in solvent and dry with compressed air.

INSTALLATION

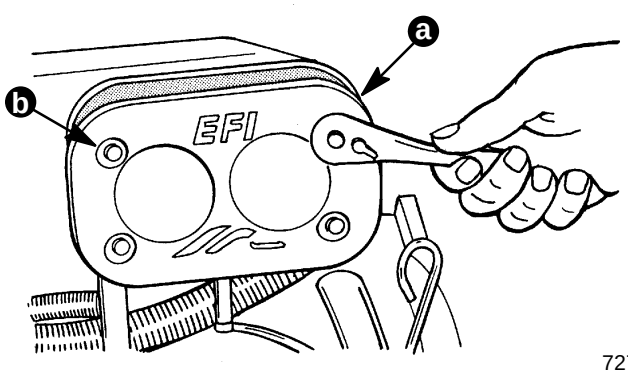
1. Install flame arrestor to throttle body.
2. Apply Loctite 242 to threads of studs. Install four flame arrestor mounting cap nuts. Torque cap nuts to 50 lb. in. (6 N·m).

Throttle Body

NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

REMOVAL

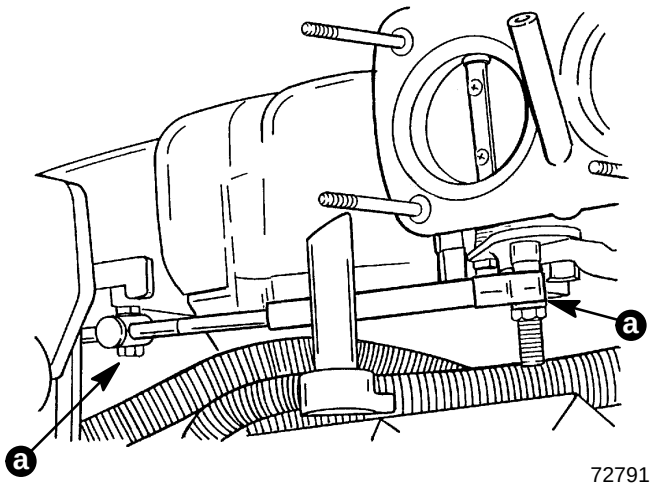
1. Remove four flame arrestor mounting cap nuts and remove flame arrestor from throttle body.



72790

a - Flame Arrestor
b - Cap Nuts (4)

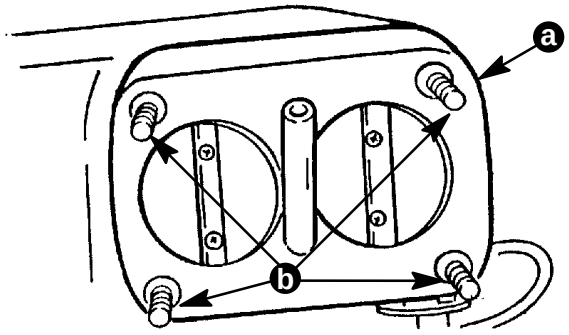
2. Disconnect throttle linkage.



72791

a - Throttle Linkage Connections

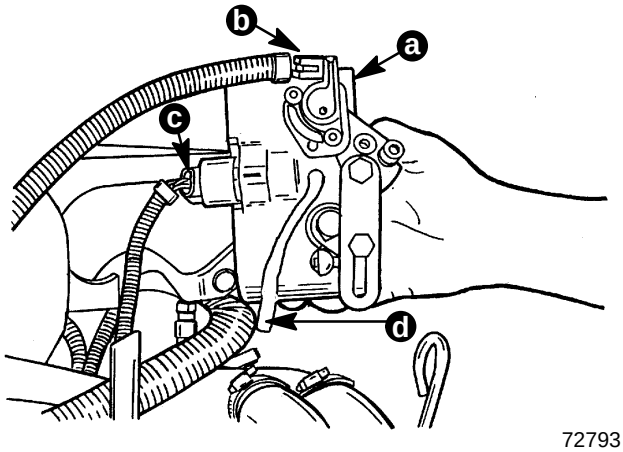
3. Remove four throttle body mounting studs using a stud driver.



72792

a - Throttle Body
b - Throttle Body Mounting Studs

4. Turn throttle body as shown and disconnect TP, drain tube and IAC electrical connectors.



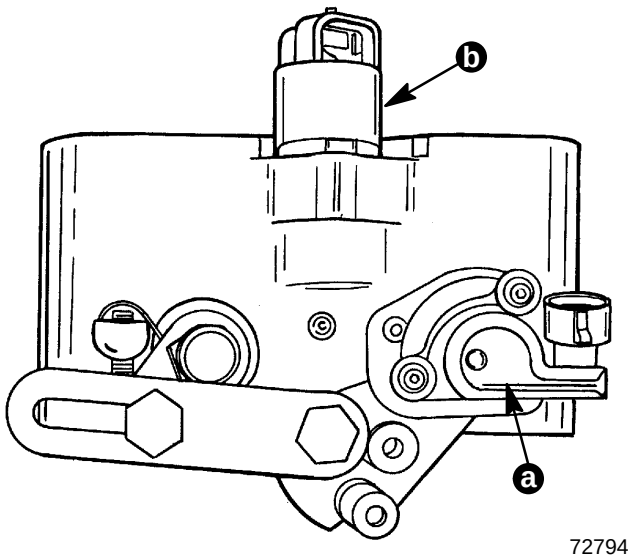
72793

a - Throttle Body
b - Throttle Position (TP) Sensor
c - Idle Air Control (IAC) Valve
d - Drain Tube

IMPORTANT: To prevent damage to throttle valve, it is essential that throttle body be placed on a holding fixture before performing service.

IMPORTANT: Insert a clean shop towel into the opening of the plenum to prevent foreign material from entering the engine.

5. Remove TP with O-ring and IAC valve with O-ring from throttle body.



72794

a - Throttle Position (TP) Sensor
b - Idle Air Control (IAC) valve

CLEANING AND INSPECTION

IMPORTANT: DO NOT use cleaners containing methyl ethyl ketone. It is not necessary for cleaning throttle bore and valve deposits.

IMPORTANT: DO NOT allow the TP and IAC valve to come into contact with solvent or cleaner.

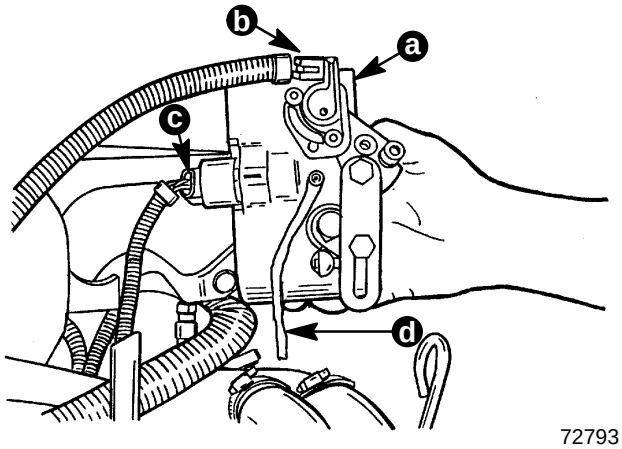
IMPORTANT: Use care when removing gasket material from plenum and throttle body. Failure to do so could result in damage to the plenum and throttle body.

1. Carefully remove all gasket material from plenum and throttle body.
2. Thoroughly clean all parts of throttle body. Make certain that all passages are free of dirt and burrs.
3. Inspect mating surfaces for damage that could affect gasket sealing.
4. Inspect throttle body for cracks in casting.
5. Inspect throttle plates, linkage, return springs, etc., for damage, wear and foreign material.
6. Check plenum for loose parts and foreign material.

INSTALLATION

NOTE: *To prevent difficult removal of fasteners and damage to fastener heads, do not use a higher strength thread locking compound than recommended.*

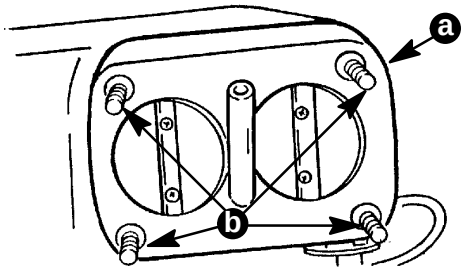
7. Connect TP and IAC electrical connectors, then install throttle body with new gasket using four throttle body mounting studs.



72793

a - Throttle Body
b - Throttle Position (TP) Sensor
c - Idle Air Control (IAC) Valve
d - Sight Tube

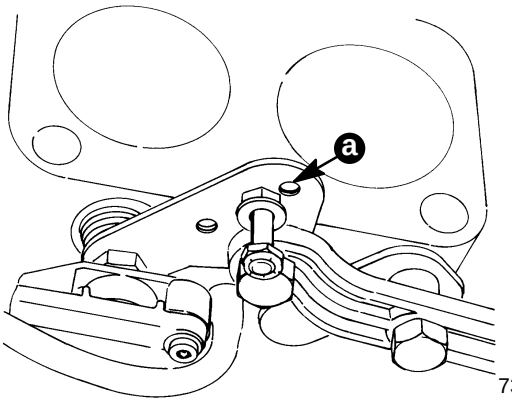
8. Apply Loctite 242 to threads of studs. Using a stud driver, torque studs to 165 lb. in. (18.6 N·m).



72792

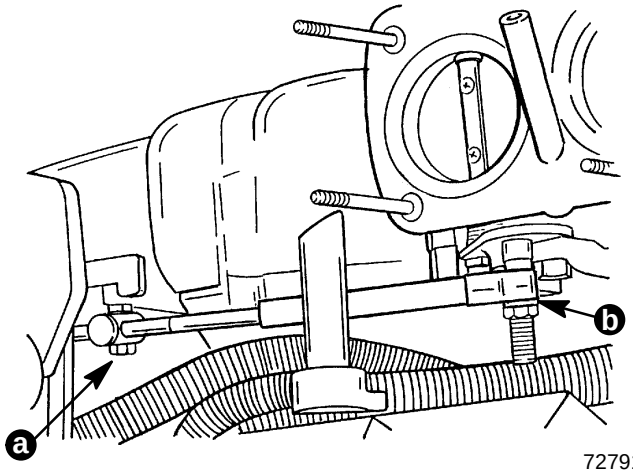
a - Throttle Body
b - Throttle Body Mounting Studs

NOTE: *If Boat is equipped with Quicksilver Zero Effort Controls, the throttle cable mounting stud must be most forward position on throttle lever.*



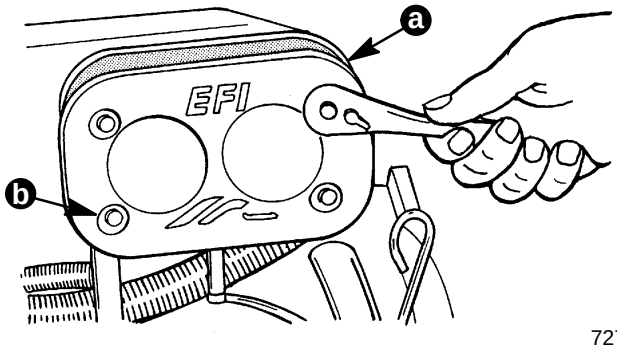
a - Position For Zero Effort Controls

9. Connect throttle linkage. Secure cable barrel anchor stud with locknut and tighten securely. Secure cable end guide to lever stud. Thread locknut on stud until it contacts end guide.



a - Cable Barrel Anchor Stud
b - Locknut

10. Install flame arrestor to throttle body. Apply Loctite 242 to threads of studs. Install four flame arrestor mounting cap nuts. Torque cap nuts to 50 lb. in. (6 N·m).



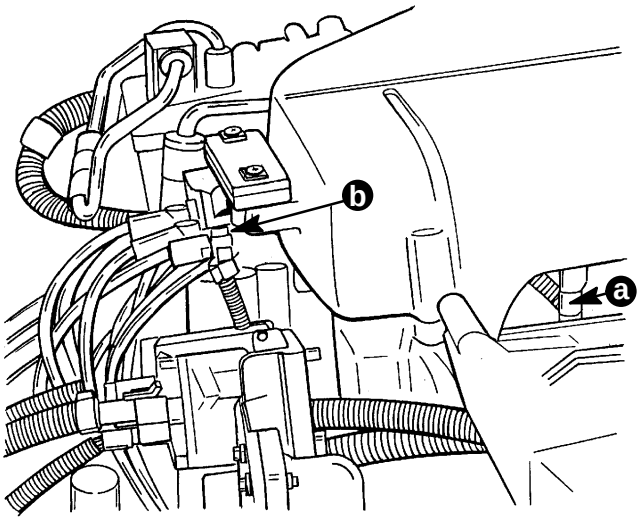
a - Flame Arrestor
b - Cap Nuts (4)

Plenum

NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

REMOVAL

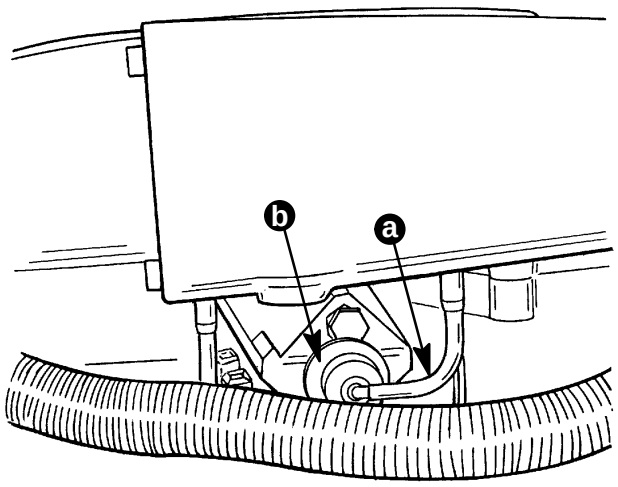
1. Remove flame arrestor and throttle body as outlined previously.
2. Disconnect IAT and MAP sensor electrical connectors



.

a - Intake Air Temperature (IAT) Sensor
b - Manifold Absolute Pressure (MAP) Sensor

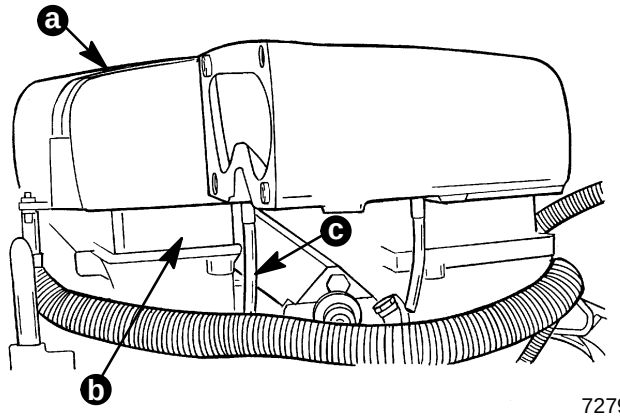
3. Disconnect reference line at pressure regulator.



72796

a - Reference Line
b - Pressure Regulator

4. Remove twelve plenum mounting fasteners and lift straight up from intake manifold. Turn plenum slightly and rest on intake manifold as shown. Disconnect drain line at plenum and remove plenum.



72797

a - Plenum
b - Intake Manifold
c - Drain Line

IMPORTANT: Place a clean shop towel over each of the eight intake manifold openings to prevent foreign material from entering the engine.

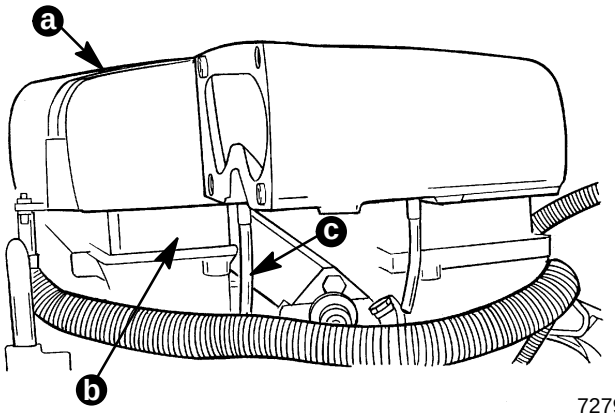
CLEANING AND INSPECTION

IMPORTANT: Use care when removing gasket material from intake manifold and plenum. Failure to do so could result in damage to the intake manifold and plenum.

1. Carefully remove all gasket material from intake manifold and plenum.
2. Clean plenum in solvent and dry with compressed air.
3. Inspect mating surfaces for damage that could affect gasket sealing.
4. Inspect plenum for cracks in casting.

INSTALLATION

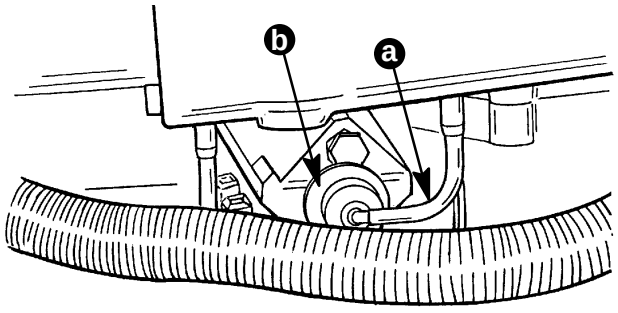
1. Install one gasket onto each of the four intake manifold trumpets.
2. Rest plenum on intake manifold as shown. Connect drain line at plenum. Lower plenum evenly onto intake manifold and install twelve plenum mounting fasteners. Torque fasteners to 150 lb. in. (17 N·m).



72797

a - Plenum
b - Intake Manifold
c - Drain Line

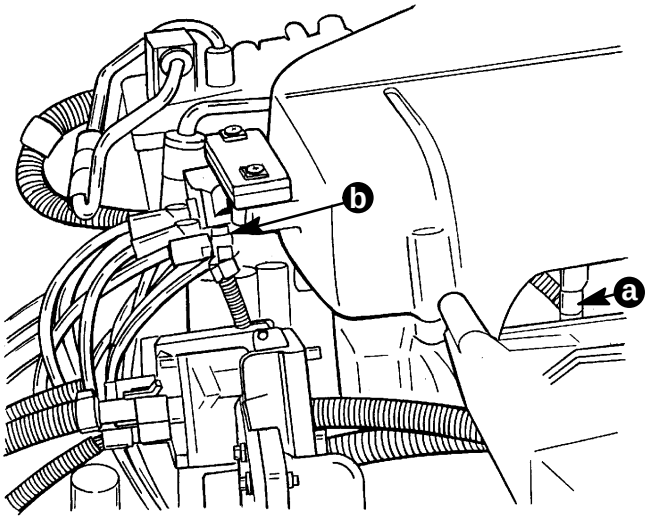
3. Connect reference line to pressure regulator.



72796

a - Reference Line
b - Pressure Regulator (VST Models) Or Fuel Damper (Cool Fuel Models)

4. Connect IAT and MAP sensor electrical connectors.



72795

a - Intake Air Temperature (IAT) Sensor
b - Manifold Absolute Pressure (MAP) Sensor

5. Install throttle body and flame arrestor as outlined previously.

Intake Manifold

NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

REMOVAL

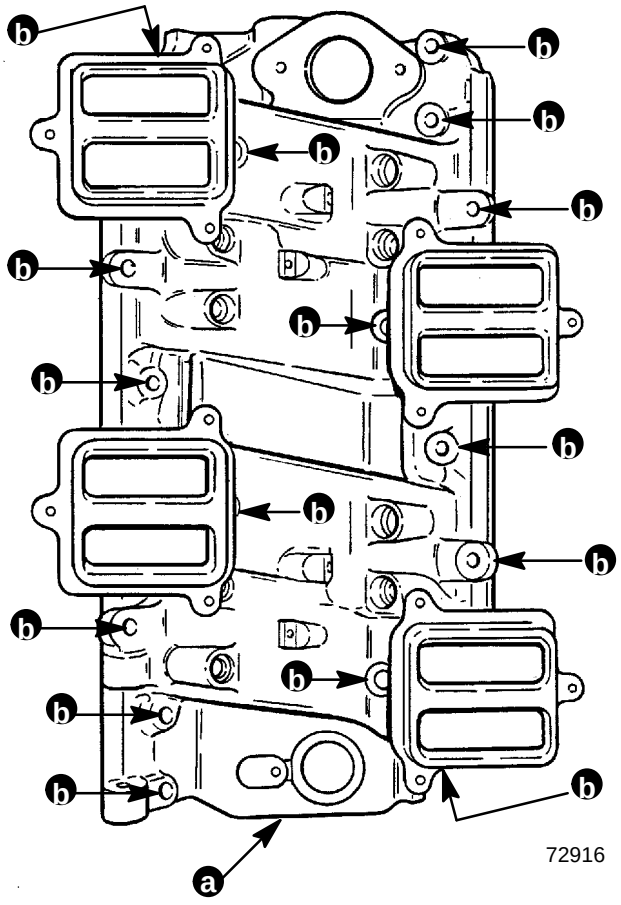
1. Drain engine cooling system. Refer to Section 6A, "Seawater Cooled Models."
2. Remove flame arrestor, throttle body and plenum as outlined previously.
3. Disconnect hoses from thermostat housing.
4. Disconnect intake manifold to circulating pump by-pass hose from circulating pump.
5. Disconnect all electrical leads necessary for intake manifold removal, including fuel injector and distributor connections. Carefully move wiring away from intake manifold.
6. Disconnect crankcase ventilation hoses from rocker arm covers.
7. Remove distributor cap.
8. Scribe a line on the distributor housing marking rotor position. Also, mark position of distributor housing on intake manifold.
9. Remove distributor housing hold-down bolt and clamp.
10. Remove distributor from intake manifold.

IMPORTANT: DO NOT crank engine over after distributor has been removed.

11. Disconnect inlet fuel line at vapor separator tank (VST) and mechanical fuel pump and remove inlet fuel line.
12. Disconnect all miscellaneous items that will prevent removal of manifold.

IMPORTANT: It may be necessary to pry intake manifold away from cylinder heads and block in next step. Use extreme care to prevent damage to sealing surfaces.

13. Remove intake manifold bolts, then remove intake manifold along with VST, fuel rail and injectors.



72916

a - Intake Manifold
b - Bolt Locations

NOTE: *If intake manifold requires replacement, transfer all remaining parts to new manifold.*

Index

CLEANING AND INSPECTION

1. Clean gasket material from all mating surfaces.

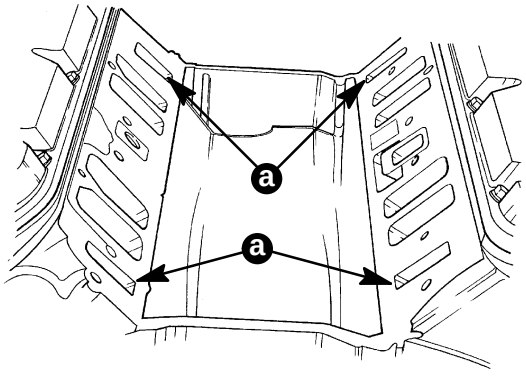
IMPORTANT: When cleaning cylinder head mating surface, DO NOT allow gasket material to enter engine crankcase or intake ports.

2. Clean excessive scale and deposits from the water passages.
3. Inspect manifold for cracks or scratches. Machined surfaces must be clean and free of all marks or deep scratches or leaks may result.
4. Inspect intake passages for varnish buildup or other foreign material. Clean as necessary.

INSTALLATION

IMPORTANT: When installing intake manifold gaskets in the next step, be sure to install gasket with marked side up. Also, both gaskets are NOT identical. Install gaskets on their respective sides of the engine. DO NOT use ANY other gasket than that which is recommended.

1. Apply Quicksilver Perfect Seal to both sides of intake manifold gasket around coolant passages.



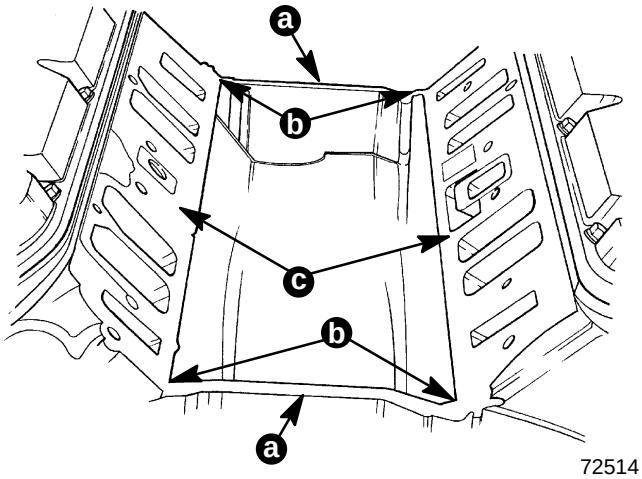
72514

a - Coolant Passages

⚠ WARNING

Be sure to read and follow package label directions when using bellows adhesive.

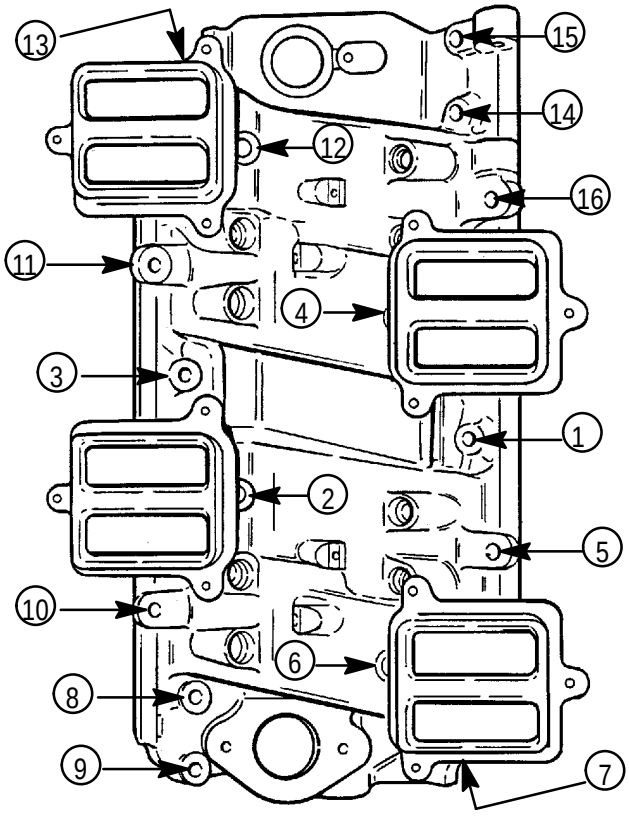
2. Using Quicksilver Bellows Adhesive, glue neoprene gaskets to engine block between cylinder heads.
3. Apply a small amount of RTV Sealer on neoprene gasket ends.



72514

a - Neoprene Gaskets
b - RTV Sealer
c - Gaskets

4. Set intake manifold gaskets in place, aligning bolt holes.
5. Carefully install intake manifold assembly and torque bolts to 25 lb. ft. (34 N·m) in the sequence shown.



72916

Intake Manifold Torque Sequence

6. Connect all miscellaneous items which were disconnected from manifold during removal.
7. Connect inlet fuel line at vapor separator tank (VST) and mechanical fuel pump.
8. Align rotor, housing and intake manifold using scribe marks.
9. Slowly lower distributor through intake manifold and into position. If distributor shaft won't drop into position, back it out and insert a screwdriver into the hole to turn the oil pump drive shaft. Repeat this adjustment as many times as needed until the distributor can be firmly seated and all components are in alignment.
10. Install hold-down clamp over distributor and bolt it securely to engine surface. Torque bolt to 30 lb. ft. (40 N·m).
11. Install distributor cap and secure in place with two screws.
12. Connect crankcase ventilation hoses to rocker arm covers.
13. Install all electrical leads, including fuel injector and distributor connections. (Refer to wiring diagrams.)
14. Connect intake manifold to circulating pump bypass hose.
15. Connect hoses to thermostat housing.
16. Install plenum, throttle body and flame arrestor as outlined previously.

IMPORTANT: Before proceeding to the following step, be certain that engine will obtain an adequate supply of water for cooling. Refer to Section 6A, "Seawater Cooled Models."

17. Start engine. Adjust ignition timing and check hose connections, gaskets and seals for leaks.
18. Inspect fuel line connections for fuel leaks.

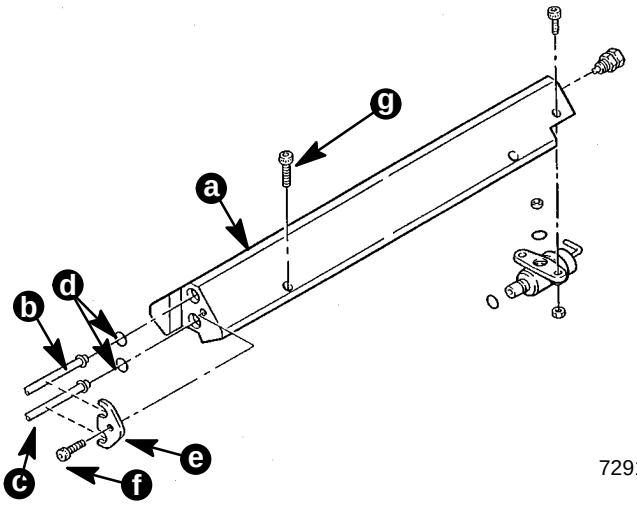
Fuel Rail and Injectors

Fuel Rail

NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

REMOVAL

1. Remove flame arrestor, throttle body, and plenum as outlined in this section.
2. Disconnect electrical connector at each fuel injector.
3. Remove fuel line retainer from fuel rail. Remove inlet and outlet fuel lines from fuel rail.



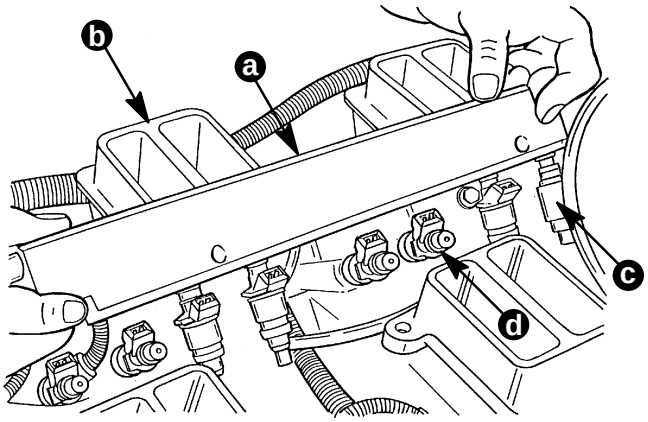
72915

a - Fuel Rail
b - Fuel Inlet Line
c - Fuel Outlet Line
d - O-Rings
e - Fuel Line Retainer
f - Screw
g - Fuel Rail Mounting Screws

4. Remove fuel rail mounting screws.
5. When facing front of engine, remove fuel rail as follows:

NOTE: *The left bank fuel injectors are to remain fully seated in the fuel rail throughout removal, while the right bank fuel injectors are to remain fully seated in the intake manifold throughout removal.*

   a. Working from front of engine to rear, slide the first front right bank fuel injector from the fuel rail. Next, slide the first front left bank fuel injector from the intake manifold. Continue sliding fuel injectors from their respective bores working back and forth toward rear of engine until fuel rail is free.



72798

a - Fuel Rail
b - Intake Manifold
c - Front Right Bank Fuel Injector
d - Front Left Bank Fuel Injector

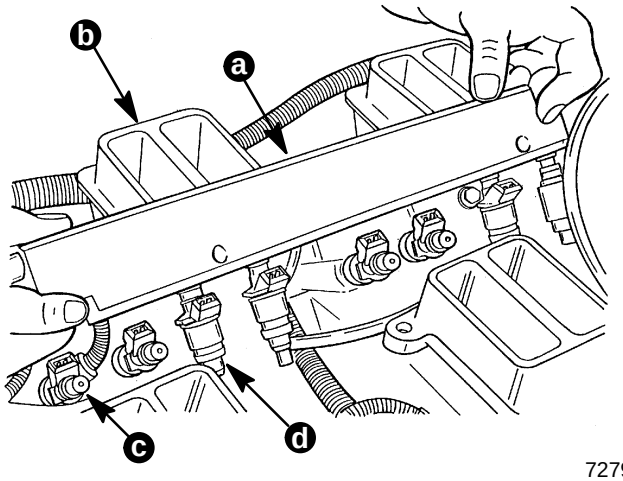
CLEANING AND INSPECTION

Inspect fuel injector seating area in fuel rail for pitting, nicks, burrs or irregularities, use a magnifying glass if necessary. If any of the above is present, replace the fuel rail.

INSTALLATION

NOTE: *Before installing fuel injectors, lubricate new fuel injector O-rings using a water/soap solution.*

1. When standing at front of engine, install fuel rail as follows:
   a. Install four left bank fuel injectors into left bank of fuel rail.
   b. Install four right bank fuel injectors into right bank of intake manifold.
   c. Working from rear of engine to front, insert the first rear left bank fuel injector into the intake manifold. Next, insert the first rear right bank fuel injector into the fuel rail. Continue inserting fuel injectors into their respective bores working back and forth toward front of engine until all fuel injectors are in place.

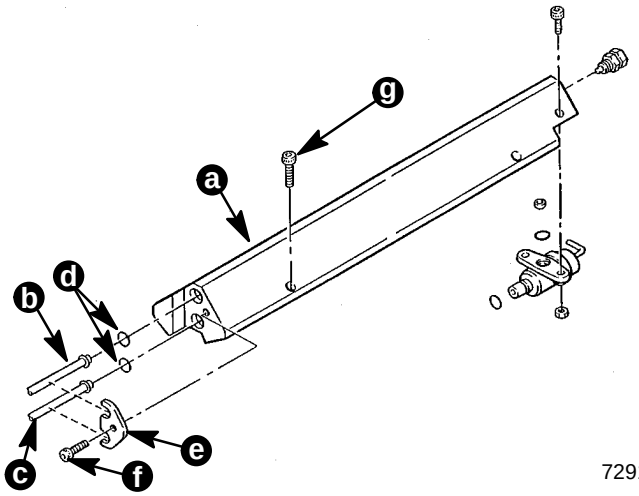


72798

a - Fuel Rail
b - Intake Manifold
c - Rear Right Bank Fuel Injector
d - Rear Left Bank Fuel Injector

2. Install fuel rail mounting bolts and torque to 105 lb. in. (12 N·m).

3. Install new O-rings on fuel inlet and outlet lines. Lubricate O-rings using a water soap solution and install lines to fuel rail. Secure fuel line retainer to fuel rail using screw.



72915

a - Fuel Rail
b - Fuel Inlet Line
c - Fuel Outlet
d - O-Rings
e - Fuel Line Retainer
f - Screw
g - Fuel Rail Retaining Screws

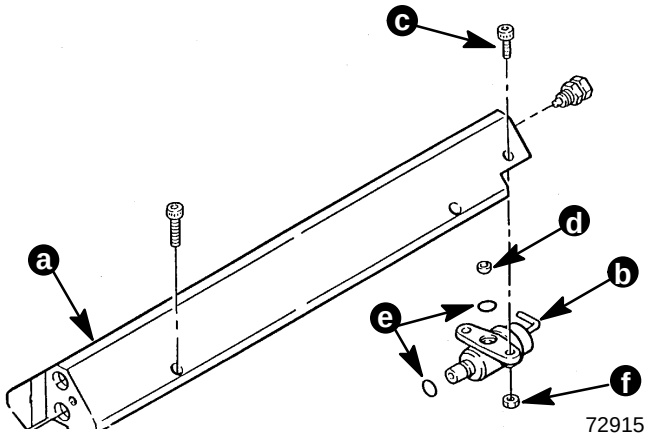
4. Connect electrical connector at each fuel injector.
5. Install plenum, throttle body and flame arrestor as outlined in this section.

Pressure Regulator

NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

REMOVAL

1. Remove flame arrestor, throttle body, plenum and fuel rail as outlined in this section.
2. Remove pressure regulator attaching screws and nuts, and remove pressure regulator.



72915

a - Fuel Rail
b - Pressure Regulator
c - Screw
d - Filter
e - O-Rings
f - Nut

3. Carefully remove filter from fuel rail using an awl or equivalent tool.

CLEANING AND INSPECTION

1. Inspect pressure regulator seating area on fuel rail for pitting, nicks, burrs or irregularities. Use a magnifying glass if necessary. If any of the above is present, replace the fuel rail.
2. Clean filter of any debris using solvent. Dry using compressed air.

INSTALLATION

1. Install filter into appropriate bore of fuel rail.
2. Install new pressure regulator O-rings using a water and soap solution.
3. Carefully slide pressure regulator into fuel rail.
4. Apply Loctite 8831 to threads of attaching screws. Install screws and nuts and torque to 88-124 lb. in. (10-14 N·m).
5. Install fuel rail, plenum, throttle body and flame arrestor as outlined in this section.
6. With engine OFF, cycle ignition switch to ON wait 2 seconds, and then OFF, four times waiting 10 seconds after each key off to prime the fuel system and check for leaks.

Fuel Injectors

NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

REMOVAL

NOTE: *Use care in removing fuel injectors to prevent damage to the electrical connector and nozzle.*

IMPORTANT: The fuel injector is an electrical component. DO NOT soak in any liquid cleaner or solvent, as damage may result.

1. Remove flame arrestor, throttle body, plenum and fuel rail as outlined in this section.
2. Remove fuel injectors from fuel rail and intake manifold.

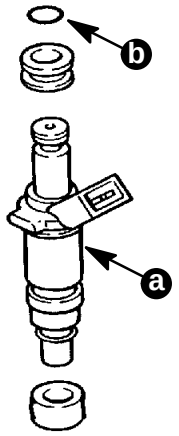
CLEANING AND INSPECTION

Inspect fuel injectors for damage; replace if necessary.

INSTALLATION

IMPORTANT: When replacing injectors, be certain to replace with the identical part and part number. Other injectors may have the same appearance, yet have a different part number and be calibrated for a different flow rate, and if installed, would cause performance difficulty or damage to the ECM.

1. Install new O-rings on fuel injectors. Lubricate O-rings using a water soap solution.



72799

a - Fuel Injector
b - O-Ring

2. Install fuel injectors as outlined in "Fuel Rail" and "Intake Manifold."
3. Install fuel rail, plenum, throttle body and flame arrestor as outlined in this section.

Throttle Body Injection and Multi-Port Injection Sensor and Module Servicing

Precautions

⚠WARNING

BEFORE attempting to disconnect and remove any module or sensor, check to make sure that the engine ignition system is OFF. Then disconnect the negative (–) battery cable from the terminal. DO NOT reconnect the negative (–) battery cable until the module or sensor removed has been re-installed with secure connections.

IMPORTANT: Modules and sensors are electrical devices easily damaged by contact with liquid cleaners or solvents. Clean with a dry cloth unless specifically directed to do otherwise.

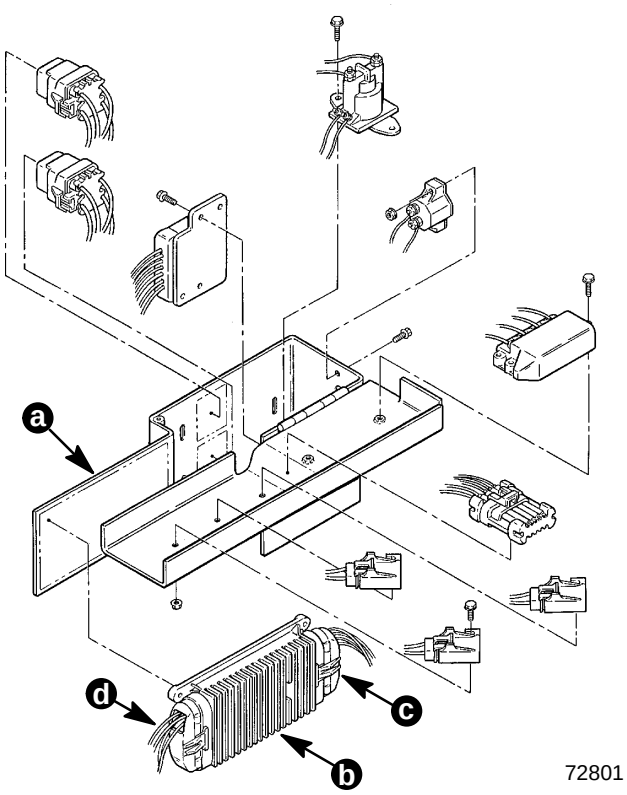
Electronic Control Module (ECM)

IMPORTANT: The ECM is a sensitive electrical device, subject to electrostatic damage. Therefore, take care not to touch connector pins when removing or installing the module.

NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

REMOVAL

1. Disconnect J1 and J2 electrical connectors at engine control module (ECM).



72801

a - Electrical Bracket
b - ECM
c - J1- Electrical Connector (Front Connector)
d - J2- Electrical Connector (Rear Connector)

2. Remove ECM from electrical bracket.

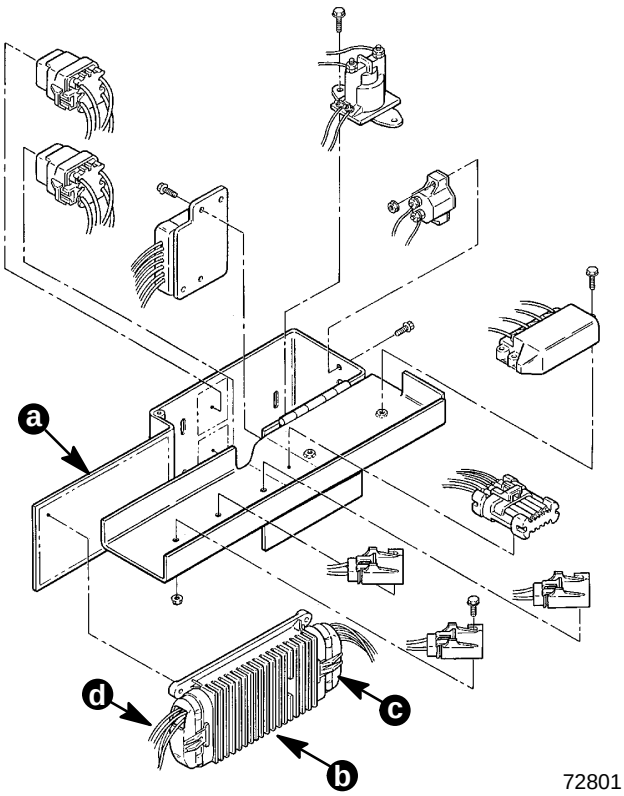
CLEANING AND INSPECTION

1. Clean the exterior of the ECM with a dry cloth being careful to avoid contact with connector pins.
2. Inspect outer surfaces for any obvious damage
3. Visually inspect electrical pins at both ends of ECM for straightness and corrosion.
4. Visually inspect J1 and J2 connectors on the wiring harness for corrosion and terminals that may have backed of the harness.

NOTE: *The ECM is a sealed electrical component. If a Code 51 check has shown it to be defective, replace the unit with another ECM having the same part number and service number as the original.*

INSTALLATION

1. Mount new ECM to electrical bracket.
2. Connect J1 and J2 electrical connectors to the ECM.



72801

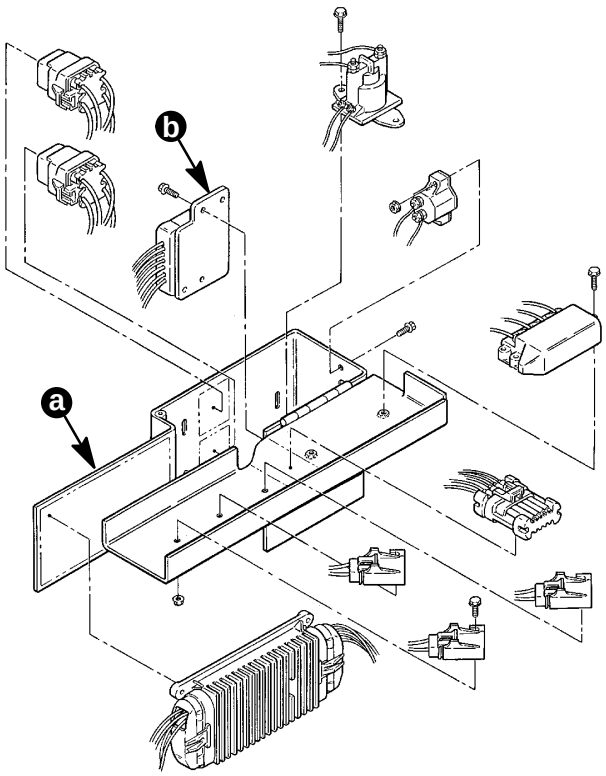
a - Electrical Bracket
b - ECM
c - J1- Electrical Connector (Front Connector)
d - J2- Electrical Connector (Rear Connector)

Knock Sensor (KS) Module

NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

REMOVAL

1. Remove Knock Sensor from electrical bracket.



72801

a - Electrical Bracket
b - Knock Sensor (KS) Sensor

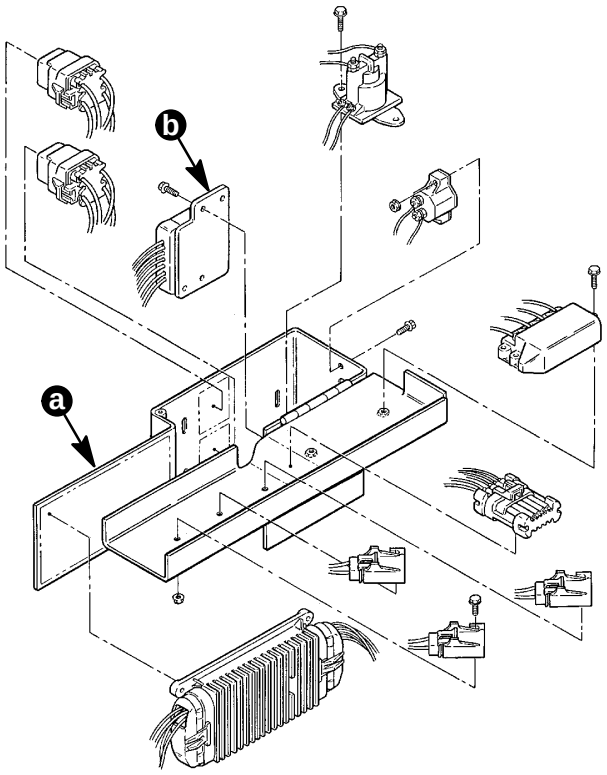
2. Disconnect electrical connector at Knock Sensor (KS) module.

CLEANING AND INSPECTION

1. Clean the external surfaces of the KS module with a dry cloth.
2. Inspect surfaces of KS module for evidence of damage.

INSTALLATION

1. Connect electrical connector to the Knock Sensor (KS) module.
2. Mount KS module to electrical bracket.



72801

a - Electrical Bracket
b - Knock Sensor (KS) Sensor

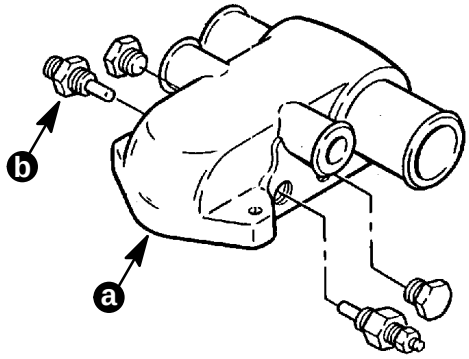
Engine Coolant Temperature (ECT) Sensor

NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

REMOVAL

NOTE: *Handle the ECT carefully as any damage to it will affect operation of the system.*

1. Disconnect electrical connector at Engine Coolant Temperature (ECT) sensor.



72799

a - Thermostat Housing
b - Engine Coolant Temperature (ECT) Sensor

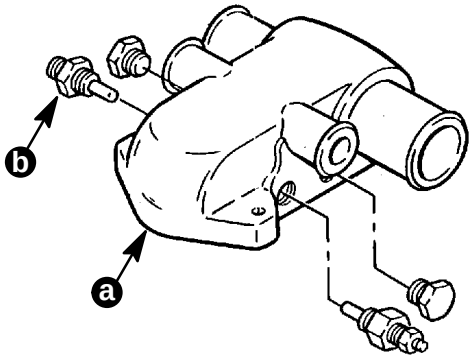
2. Remove ECT from thermostat housing.

CLEANING AND INSPECTION

1. Clean with a dry cloth, removing any excess sealant from the base threads.
2. Look for evidence of any physical damage to base or connector surfaces of the ECT.

INSTALLATION

1. Install ECT in thermostat housing. TIGHTEN HAND TIGHT PLUS 2-1/2 TURNS MAXIMUM.



72799

a - Thermostat Housing
b - Engine Coolant Temperature (ECT) Sensor

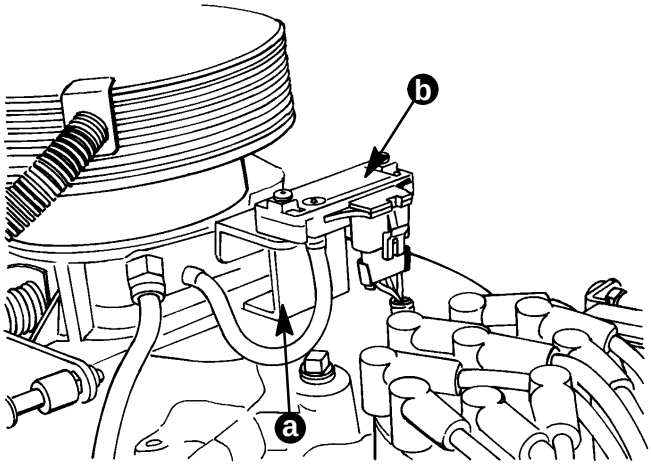
2. Connect electrical connector to ECT.

Throttle Body Injection Components-Manifold Absolute Pressure (MAP) Sensor

NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

REMOVAL

1. Disconnect electrical connector at manifold absolute pressure (MAP) sensor.



74939

a - Throttle Body Adapter Plate
b - Manifold Absolute Pressure (MAP) Sensor

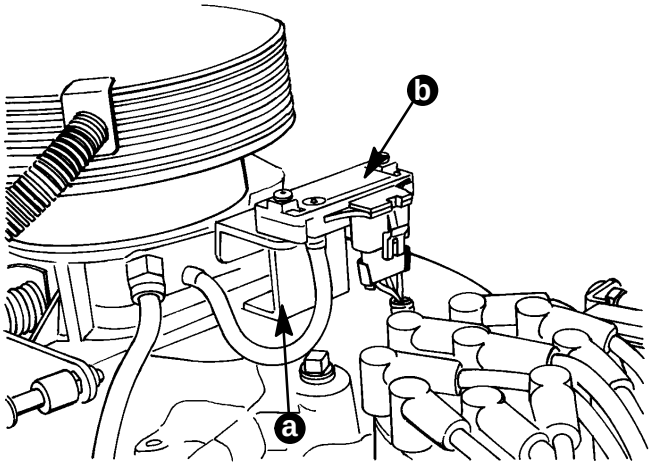
2. Remove MAP sensor from throttle body adapter.

CLEANING AND INSPECTION

1. Clean off any foreign matter with a dry cloth.
2. Inspect for any obvious signs of physical damage to the sensor.

INSTALLATION

1. Install MAP sensor to throttle body adapter using screws. Torque screws to 44-62 lb. in. (5-7 N·m).
2. Connect electrical connector to MAP sensor.



74939

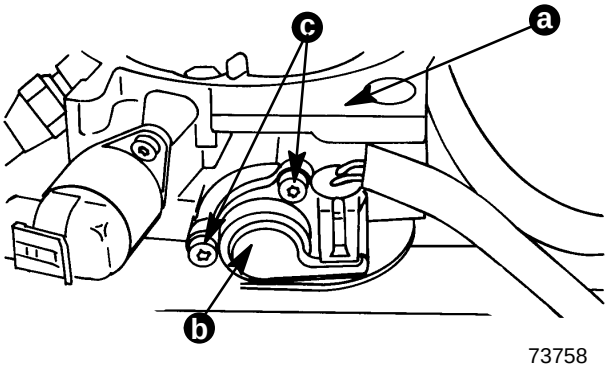
a - Throttle Body Adapter Plate
b - Manifold Absolute Pressure (MAP) Sensor

Throttle Position (TP) Sensor

NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

REMOVAL

1. Disconnect electrical connector at throttle position (TP) sensor.
2. Remove TP sensor from throttle body.



73758

a - Throttle Body
b - Throttle Position (TP) Sensor
c - Screws

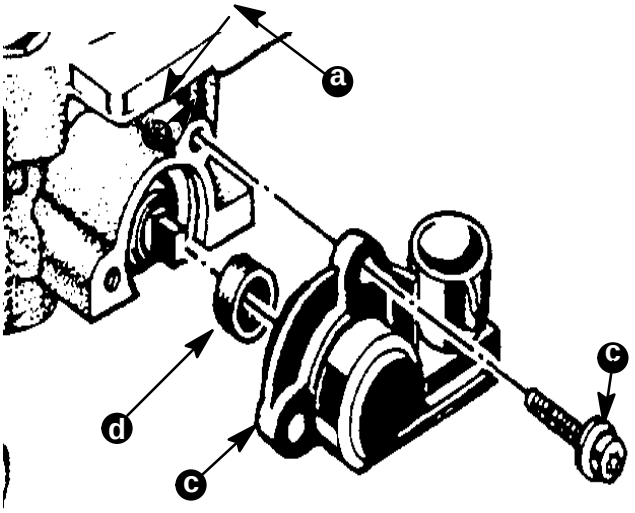
CLEANING AND INSPECTION

1. Clean the surfaces of the TP sensor with a dry cloth.
2. Inspect the TP sensor for signs of wear or damage.

INSTALLATION

IMPORTANT: If the TP sensor is to be replaced with a new unit, be sure to secure it in place with the new screws which are included in the service package.

1. Install TP sensor to throttle body using screws with washers and Loctite 242 applied to threads. Torque screws to 20 lb. in (2 N·m).



73758

a - Throttle Body
b - Throttle Position (TP) Sensor
c - Screws With Lockwashers
d - Seal

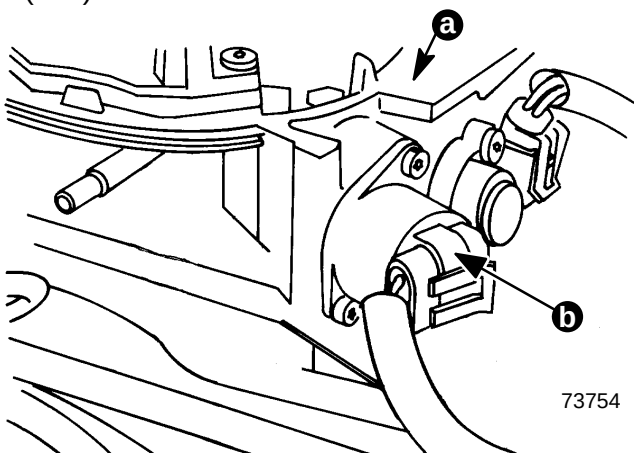
2. Connect electrical connector to TP sensor.
3. Install throttle body, throttle linkage and flame arrestor as outlined in “Throttle Body.”
4. Start engine and check for TP sensor output voltage. It should be approximately .7V at idle and 4.5V at W.O.T.

Idle Air Control (IAC) Valve

NOTICE
Refer to “Service Precautions,” in “Repair Procedures,” BEFORE proceeding.

REMOVAL

1. Remove flame arrestor, throttle cable and throttle body as outlined in “Throttle Body.”
2. Disconnect electrical connector at idle air control (IAC) valve.



73754

a - Throttle Body
b - Idle Air Control (IAC) Valve

3. Remove IAC from throttle body.

CLEANING AND INSPECTION

1. Remove and discard sealing O-ring from IAC valve. Clean sealing surfaces, pintle valve seat, and air passage with a carburetor cleaner to remove carbon deposits, being careful not to push or pull on the IAC valve pintle. Force exerted on the pintle might damage the worm drive. DO NOT use a cleaner that contains the extremely strong solvent methyl ethyl ketone.

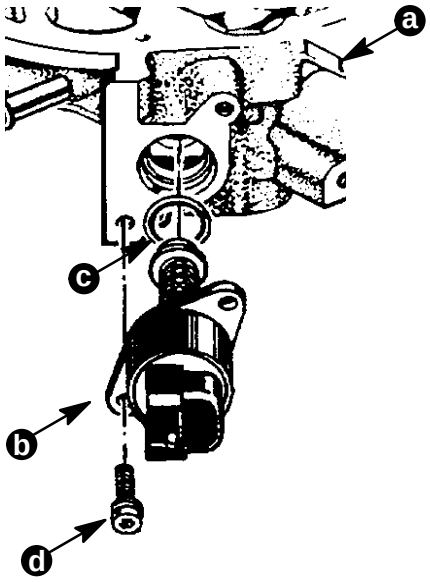
NOTE: *Shiny spots on the pintle, or seat, are normal and do not indicate misalignment or a bent pintle shaft.*

2. Inspect the entire assembly for any obvious physical damage.

INSTALLATION

IMPORTANT: If installing a new IAC valve, be sure to replace it with the correct IAC valve pintle shape and diameter are designed for the specific application.

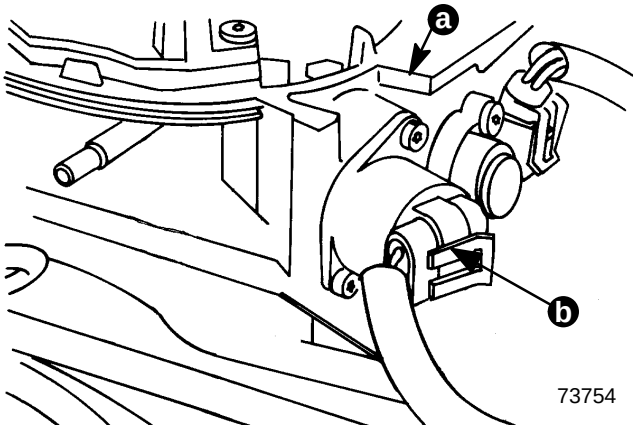
1. Install new O-ring on IAC valve.



73766

a - Throttle Body
b - Idle Air Control (IAC) Valve
c - O-Ring
d - Screws

2. Install IAC valve in throttle body using screws. Torque to 20 lb. in. (2 N·m).
3. Connect electrical connector to IAC valve.



73754

a - Throttle Body
b - Idle Air Control (IAC) Valve

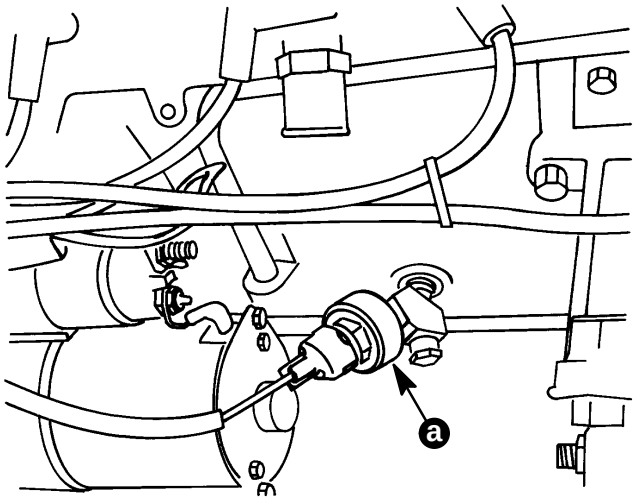
4. Reset IAC valve pintle position after reconnecting negative (–) battery cable.
   a. Turn ignition key ON for ten seconds.
   b. Turn ignition key OFF for ten seconds.
   c. Restart engine and check for proper idle operation.

Knock Sensor

NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

REMOVAL

1. Disconnect electrical connector at knock sensor located just ahead of starter motor.



73757

a - Knock Sensor

2. Remove knock sensor from engine block.

CLEANING AND INSPECTION

1. Clean knock sensor with a dry cloth, paying special attention to threads on base.
2. Inspect surfaces of knock sensor for signs of wear or physical damage.

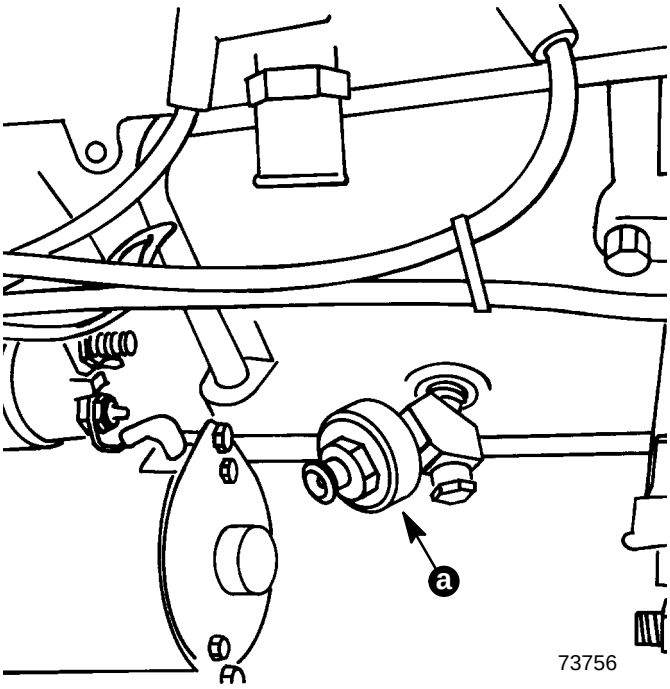
INSTALLATION

IMPORTANT: If installing a new knock sensor, be sure to replace it with an identical part. Knock sensors are very sensitive and designed for each specific application.

IMPORTANT: In the following step, it is very important that the knock sensor be torqued to the precise specification. Incorrect torquing will result in unsatisfactory performance. DO NOT use sealer on threads.

IMPORTANT: Ensure that the knock sensor is installed in the upper location on the Y-fitting.

1. Install knock sensor in engine block. Torque to 12-16 lb. ft. (16.3-21.7 N·m).



a - Knock Sensor

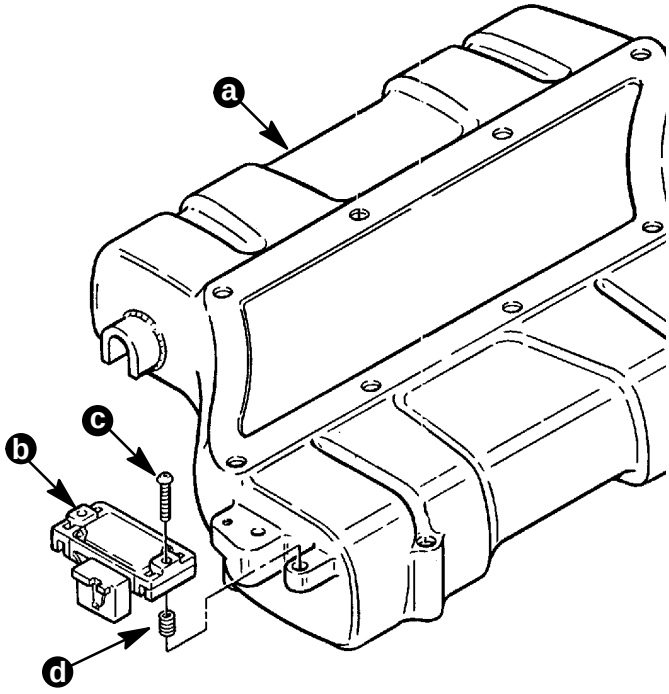
2. Connect electrical connector to knock sensor.

Multi-Port Injection Components- Manifold Absolute Pressure (MAP) Sensor

NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

REMOVAL

1. Disconnect electrical connector at manifold absolute pressure (MAP) sensor.



72802

a - Plenum
b - Manifold Absolute Pressure (MAP) Sensor
c - Screws
d - Seal

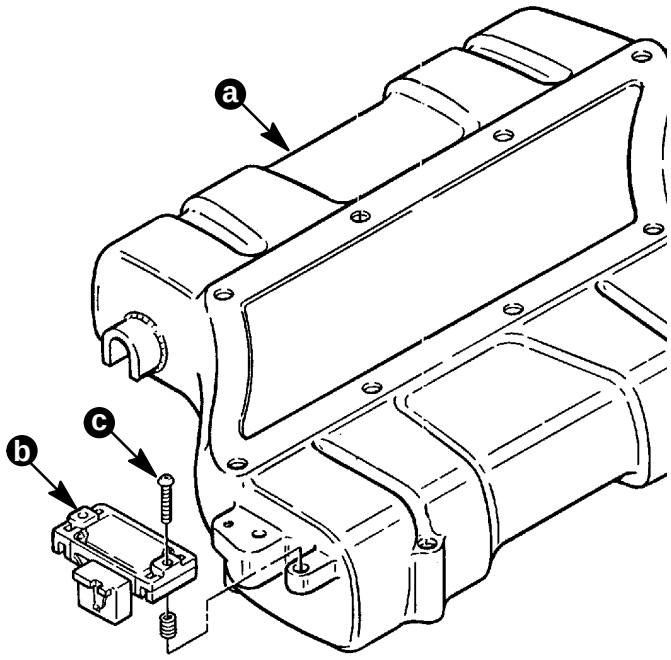
2. Remove screws from MAP sensor.
3. Remove MAP sensor from plenum.

CLEANING AND INSPECTION

1. Clean off any foreign matter with a dry cloth.
2. Inspect for any obvious signs of physical damage to the sensor.
3. Inspect seal for damage.

INSTALLATION

1. Install MAP sensor to plenum using screws. Torque screws to 44-62 lb. in. (5-7 N·m).



72802

a - Plenum
b - Manifold Absolute Pressure (MAP) Sensor
c - Screws

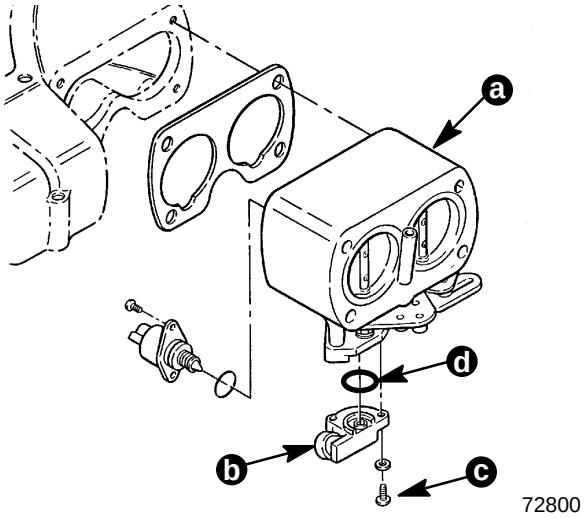
2. Connect electrical connector to MAP sensor.

Throttle Position (TP) Sensor

NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

REMOVAL

1. Remove flame arrestor, throttle cable and throttle body as outlined in "Throttle Body."



a - Throttle Body
b - Throttle Position (TP) Sensor
c - Screws With Lockwashers
d - O-Ring

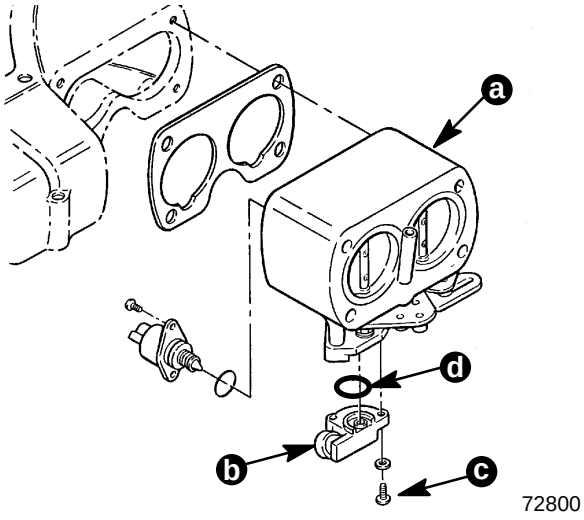
2. Remove TP from throttle body.

CLEANING AND INSPECTION

1. Clean the surfaces of the TP with a dry cloth.
2. Inspect the TP for signs of wear or damage.

INSTALLATION

1. Install TP sensor to throttle body using screws with washers and Loctite 242 applied to threads. Torque screws to 20 lb. in (2 N·m).



a - Throttle Body
b - Throttle Position (TP) Sensor
c - Screws With Lockwashers
d - O-Ring

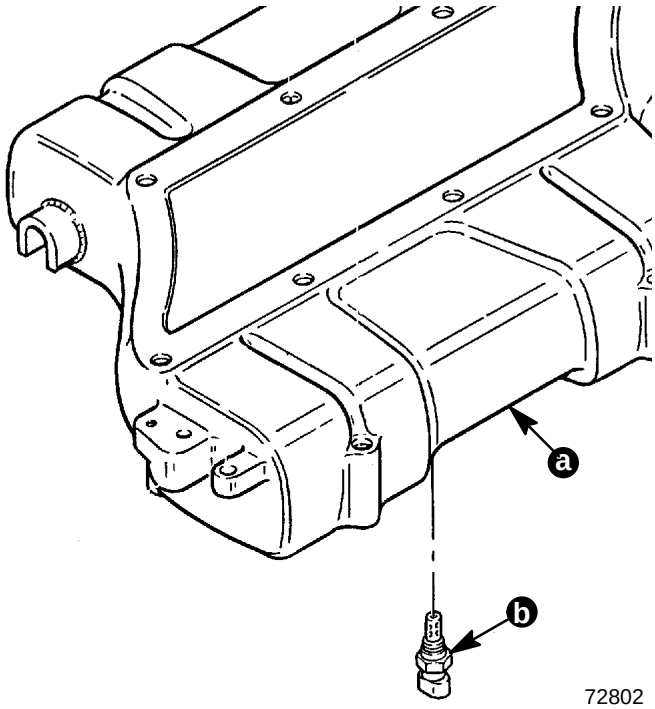
2. Install throttle body, throttle cable and flame arrestor as outlined in "Throttle Body."
3. When negative (–) battery cable has been reconnected, start engine and check for TP sensor output voltage. It should be approximately .7 V at idle and 4.5 V at W.O.T.

Intake Air Temperature (IAT) Sensor

NOTICE
Refer to “Service Precautions,” in “Repair Procedures,” BEFORE proceeding.

REMOVAL

1. Remove flame arrestor, throttle linkage, throttle body and plenum as outlined in “Plenum.”
2. Remove IAT from plenum.



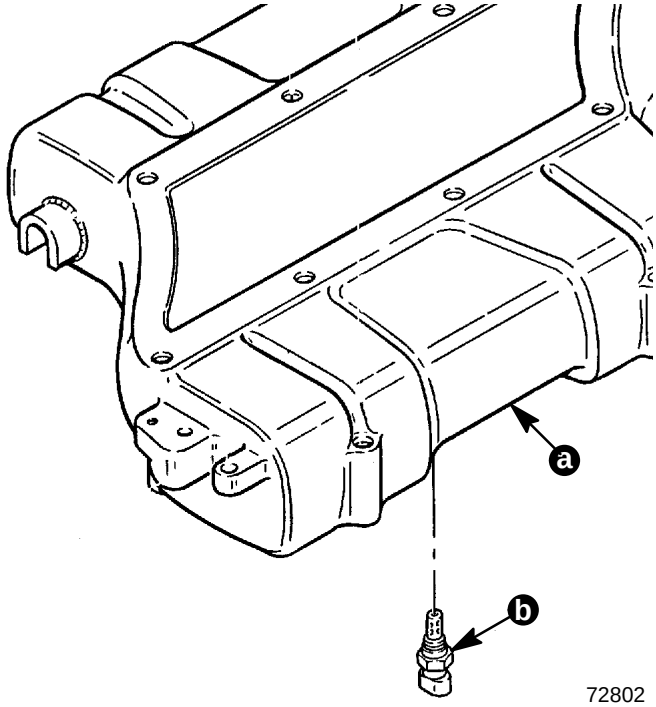
a - Plenum
b - Intake Air Temperature (IAT) Sensor

CLEANING AND INSPECTION

1. Clean the surfaces of the IAT with a dry cloth.
2. Inspect the IAT for signs of wear or damage.

INSTALLATION

1. Install IAT in plenum. Tighten 2-1/2 turns maximum.



a - Plenum
b - Intake Air Temperature (IAT) Sensor

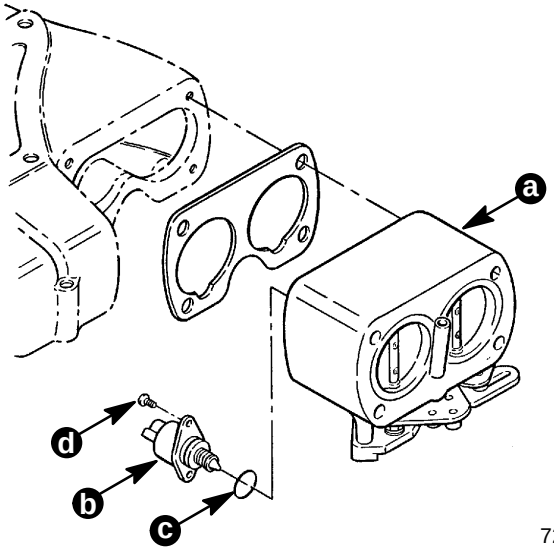
2. Install plenum, throttle body, throttle cable and flame arrestor as outlined in “Plenum.”
3. Connect electrical connector to IAT.

Idle Air Control (IAC) Valve

NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

REMOVAL

1. Remove flame arrestor, throttle cable and throttle body as outlined in "Throttle Body."
2. Disconnect electrical connector at idle air control (IAC) valve.



72800

a - Throttle Body
b - Idle Air Control (IAC) Valve
c - O-Ring
d - Screws

3. Remove IAC from throttle body.

CLEANING AND INSPECTION

1. Remove and discard sealing O-ring from IAC valve. Clean sealing surfaces, pintle valve seat, and air passage with a carburetor cleaner to remove carbon deposits, being careful not to push or pull on the IAC valve pintle. Force exerted on the pintle might damage the worm drive. DO NOT use a cleaner that contains the extremely strong solvent methyl ethyl ketone.

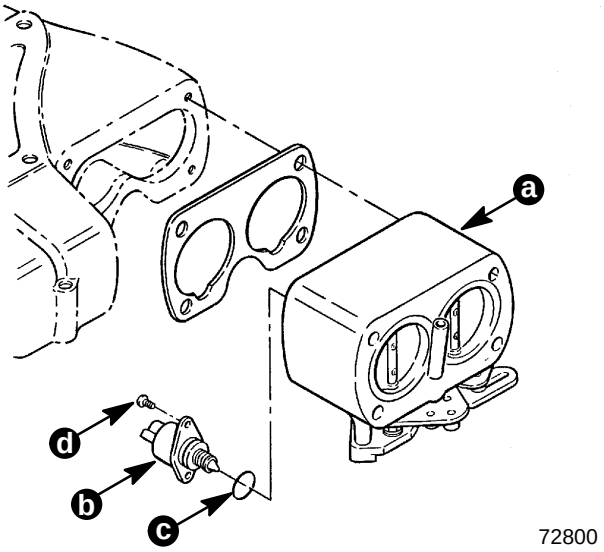
NOTE: *Shiny spots on the pintle, or seat, are normal and do not indicate misalignment or a bent pintle shaft.*

2. Inspect the entire assembly for any obvious physical damage.

INSTALLATION

IMPORTANT: If installing a new IAC valve, be sure to replace it with an identical part. IAC valve pintle shape and diameter are designed for the specific application.

1. Install new O-ring on IAC valve.



72800

a - Throttle Body
b - Idle Air Control (IAC) Valve
c - O-Ring
d - Screws

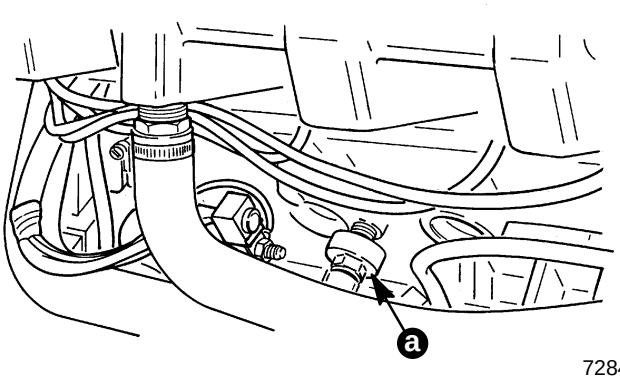
2. Install IAC valve in throttle body using screws. Torque to 20 lb. in. (2 N·m).
3. Install throttle body, throttle linkage and flame arrestor as outlined in " Throttle Body."
4. Reset IAC valve pintle position.
   a. Turn ignition key ON for ten seconds.
   b. Turn ignition key OFF for ten seconds.
   c. Restart engine and check for proper idle operation.

Knock Sensor

NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

REMOVAL

1. Disconnect electrical connector at knock sensor located just ahead of starter motor.



72846

a - Knock Sensor

2. Remove knock sensor from engine block.

CLEANING AND INSPECTION

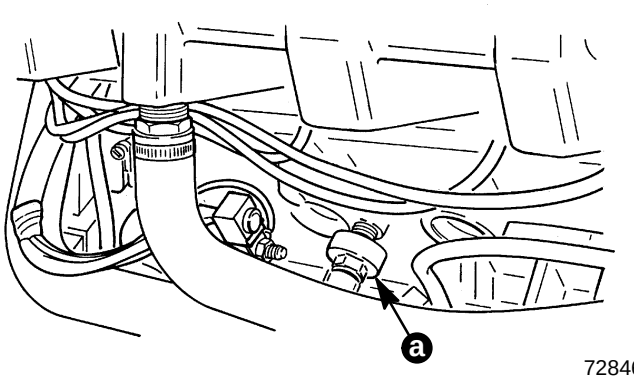
1. Clean knock sensor with a dry cloth, paying special attention to threads on base.
2. Inspect surfaces of knock sensor for signs of wear or physical damage.

INSTALLATION

IMPORTANT: If installing a new knock sensor, be sure to replace it with an identical part. Knock sensors are very sensitive and designed for each specific application.

IMPORTANT: In the following step, it is very important that the knock sensor be torqued to the precise specification. Incorrect torquing will result in unsatisfactory performance. DO NOT use sealer on threads.

1. Install knock sensor in engine block. Torque to 12-16 lb. ft. (16.3-21.7 N·m).



72846

a - Knock Sensor

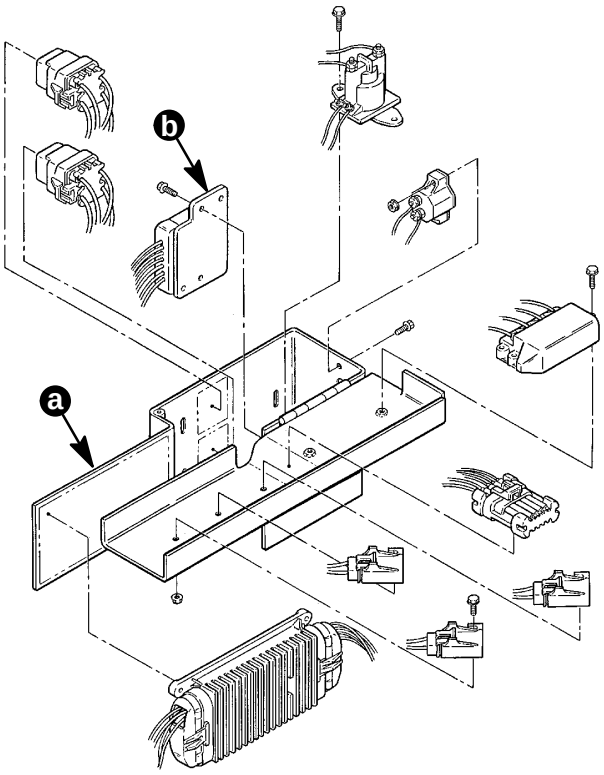
2. Connect electrical connector to knock sensor.

Knock Sensor (KS) Module

NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

REMOVAL

1. Remove KS module from electrical bracket.



72801

a - Electrical Bracket
b - Knock Sensor Module

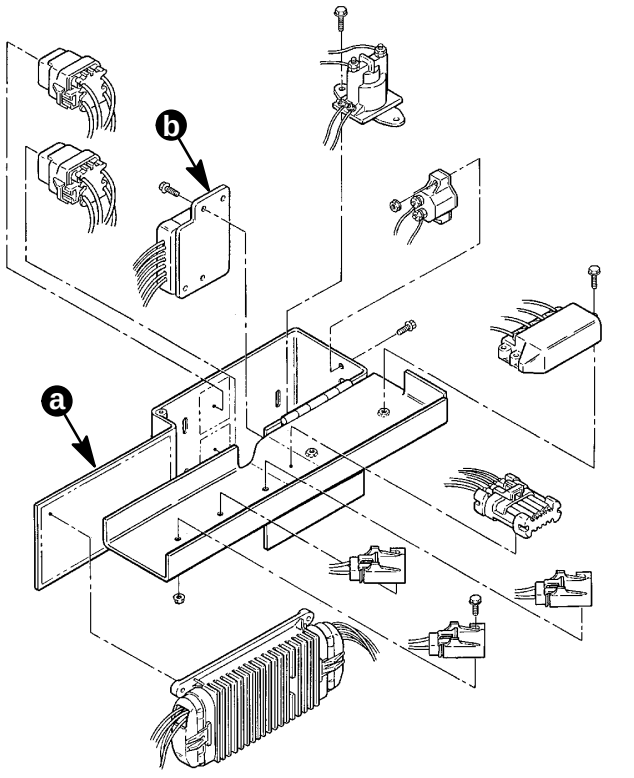
2. Disconnect electrical connector at Knock Sensor (KS) module.

CLEANING AND INSPECTION

1. Clean the external surfaces of the KS module with a dry cloth.
2. Inspect surfaces of KS module for evidence of damage.

INSTALLATION

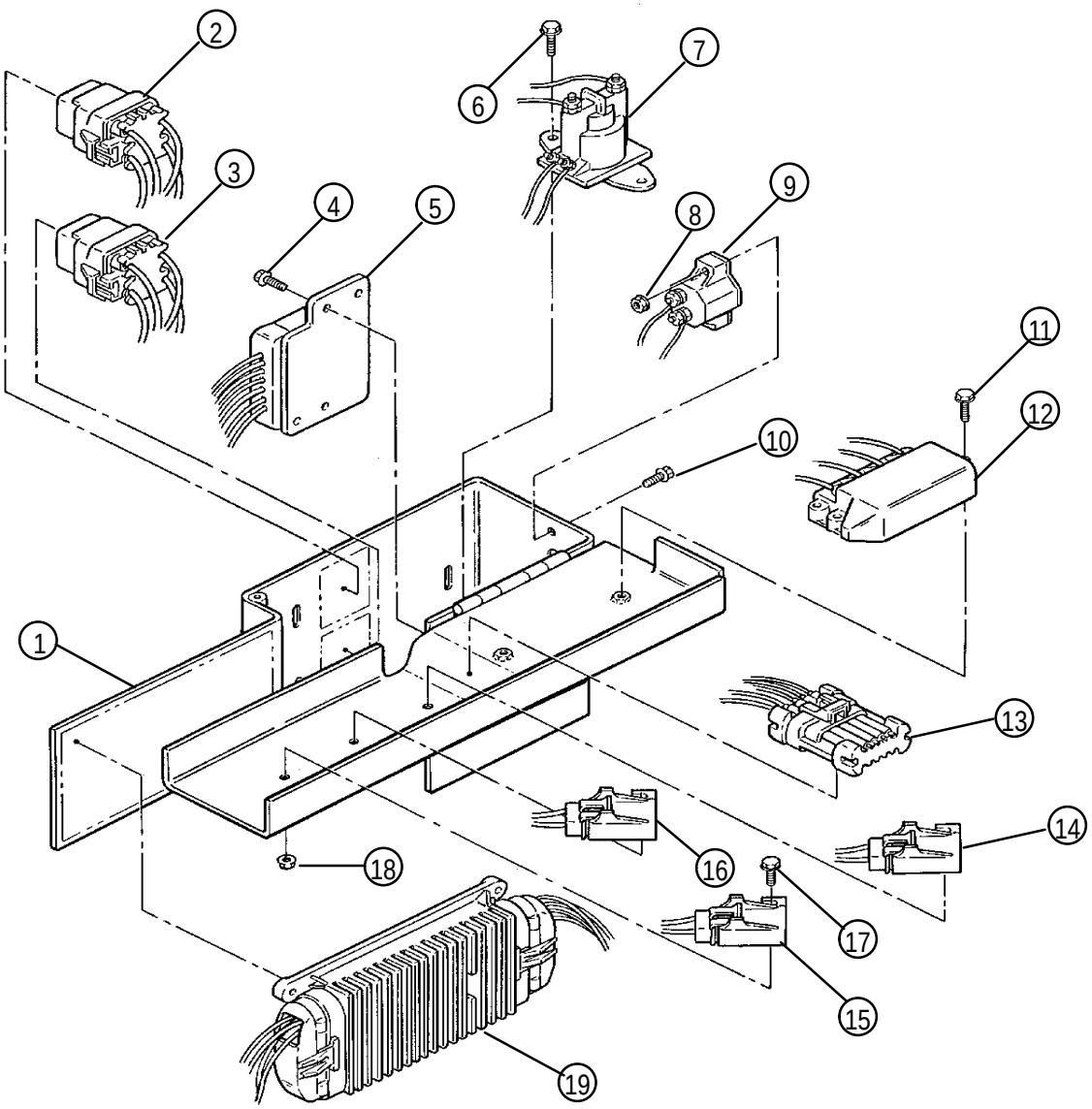
1. Mount KS module to electrical bracket.
2. Connect electrical connector to the KS module.



72801

a - Electrical Bracket
b - Knock Sensor Module

ELECTRICAL BOX (TYPICAL)



72801

1 - Bracket
2 - Relay
3 - Relay
4 - Screw
5 - Knock Sensor (KS) Sensor
6 - Screw
7 - Slave Solenoid
8 - Nut
9 - Circuit Breaker
10- Screw
11- Screw
12- MerCathode
13- Data Link Connector (DLC)
14- Circuit Breaker Fuse
15- Circuit Breaker Fuse
16- Circuit Breaker Fuse
17- Screw
18- Nut
19- Engine Control Module (ECM)

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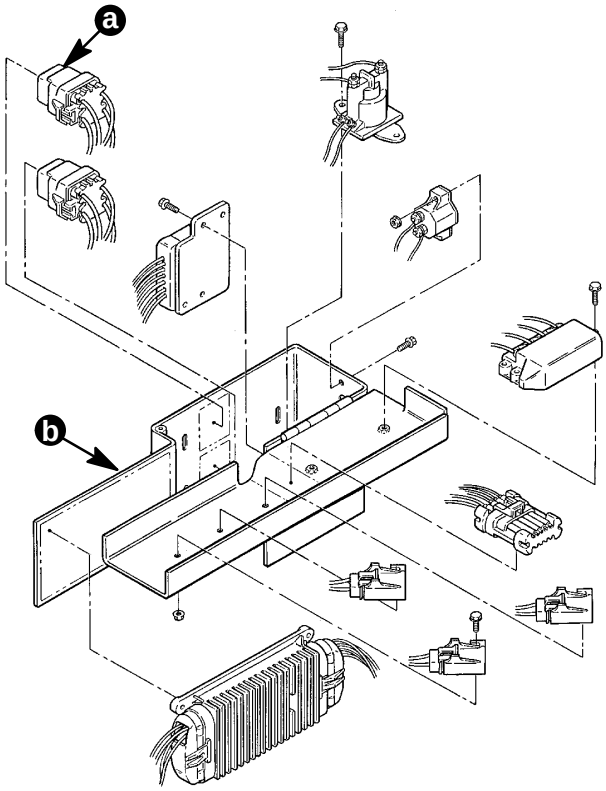
Fuel Pump Relay

NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

REMOVAL

1. Detach fuel pump relay from bracket.



72801

a - Fuel Pump Relay
b - Bracket

2. Disconnect electrical connector and remove fuel pump relay.

IMPORTANT: The fuel pump relay is an electrical component. DO NOT soak in any liquid cleaner or solvent; damage may result.

INSTALLATION

1. Insert electrical connector into fuel pump relay.
2. Attach fuel pump relay to bracket.

Ignition Control (IC) System Components

Precautions

⚠WARNING

When performing the following procedures, be sure to observe the following precautions to avoid damage to equipment or personal injury:

DO NOT touch or disconnect any ignition system parts while the engine is running.

DO NOT reverse battery cable connections. System is negative (–) ground.

DO NOT disconnect battery cables while engine is running.

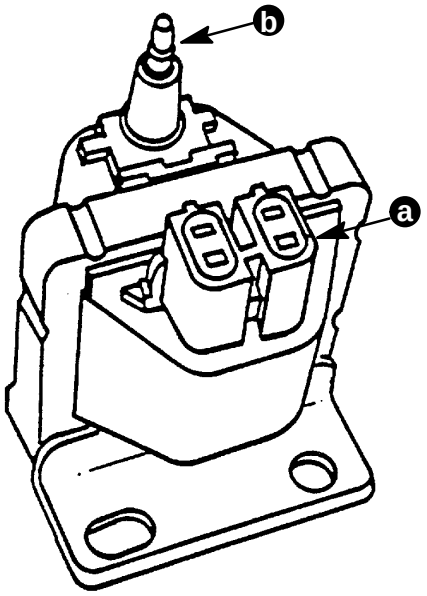
When it is necessary to move any of the wiring, whether to lift wires away from their harnesses or move harnesses to reach components, take care that all wiring is replaced in its original position and all harnesses are routed correctly. Electrical problems can result from wiring or harnesses becoming loose and moving from their original positions or from being re-routed.

Ignition Coil

NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

REMOVAL

1. Disconnect wire harness connectors at coil.



72921

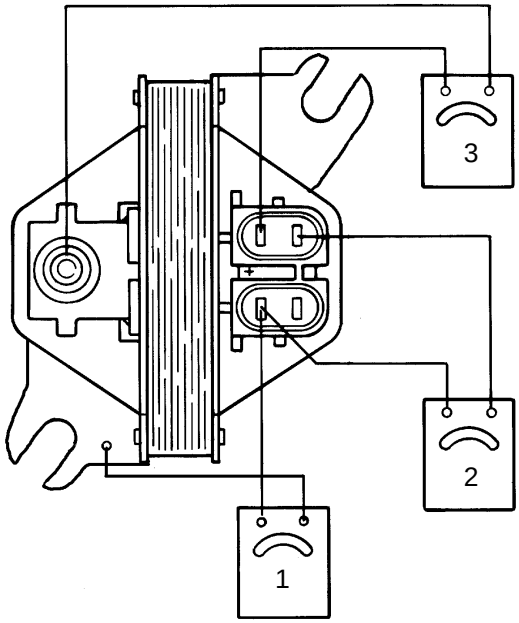
a - Wire Harness Connection
b - High Tension Coil Lead Connection

2. Remove high tension coil lead.
3. Remove coil bracket fasteners and remove coil bracket with coil.

RESISTANCE CHECK

Use an ohmmeter or the ohms function of a DVM for the following check.

1. Connect meter as shown with meter 1 in the figure below.



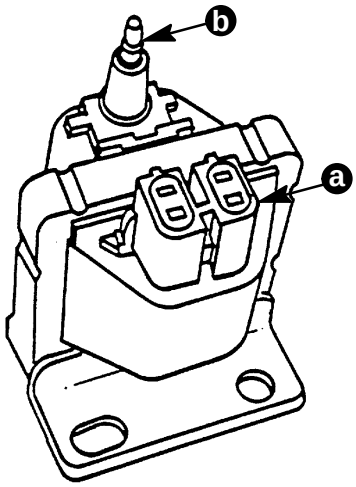
72920

2. Setting the meter to its highest ohms scale, check resistance. The reading should indicate infinite resistance. If it does not, replace the coil.
3. Connect meter as shown with meter 2 in the figure above.
4. Setting the meter to its lowest ohms scale, check resistance. The reading should be very low or zero resistance. If it is not, replace the coil.
5. Connect meter as shown with meter 3 in the figure above.
6. Setting the meter to its highest ohms scale, check resistance. The reading should not indicate infinite resistance. If it does, replace the coil.

INSTALLATION

7. Install coil bracket with coil to engine bracket using fasteners.

8. Connect high tension coil lead.



72921

a - Wire Harness Connection
b - High Tension Coil Lead Connection

9. Connect wire harness connectors.

IGNITION TIMING SET PROCEDURE

The engine must be at **NORMAL OPERATING TEMPERATURE** for this adjustment. Two items of test equipment are required: an inductive pickup timing light and either a Scan Tool, Diagnostic Code Tool, or MerCruiser Special Timing Tool (91-805747A1).

1. Connect timing light to number 1 ignition wire.
2. Connect the appropriate tool (as listed above) to the DLC connector of the wiring harness.
3. Manually adjust the engine throttle to **1800 RPM ± 200.**
4. **If Not Using MerCruiser Timing Tool:** With engine running, set the scan tool or Diagnostic Code Tool to service mode.
5. Shine the timing light at the timing mark indicator located on the timing chain cover.

NOTE: *If adjustment is needed, loosen the distributor hold-down bolt and rotate the distributor clockwise or counterclockwise to adjust the timing. Then repeat the timing light check until the specification (8 degrees BTDC) is met.*

6. Torque distributor hold-down bolt to 30 lb. ft. (40 N·m).
7. Set Scan Tool or Diagnostic Code Tool to normal mode. If using the MerCruiser Special Timing Tool, disconnect it from DLC connector.
8. Manually close throttle to bring engine down to idle state.

Spark Plug Replacement

SPARK PLUG WIRING AND BOOT PRECAUTIONS

1. **Twist boots one-half turn before removing.**
2. **When removing boot, DO NOT use pliers or other sharp tools which might tear the boot.**
3. **DO NOT force any object between the wire and the boot or through the silicone jacket of the wiring.**
4. **DO NOT pull on the wires to remove the boot. Pull on the boot or use a tool designed for this purpose.**
5. **Special care must be used when installing spark plug boots to ensure that the metal terminal within the boot is fully seated on the spark plug terminal and that the boot has not moved on the wire. If boot-to-wire movement has occurred, the boot will give a fast visual impression of being seated. To make sure that boots have been properly installed, push sideways on them. If they have been correctly installed, the boots will fit tightly with only a slight looseness. If the terminal has not been firmly seated on the spark plug, only the resistance of the rubber boot will be felt when pushed sideways.**

REMOVAL

1. Disconnect spark plug wires from spark plugs.
2. Remove spark plugs.

CLEANING AND INSPECTION

1. Clean spark plugs and spark plug wires with a dry cloth.
2. Check each spark plug for wear and gap width per MerCruiser specifications. Replace any which fail to meet the standards.
3. Check spark plug wires for damage to insulation, boots and connectors. Replace if necessary.

INSTALLATION

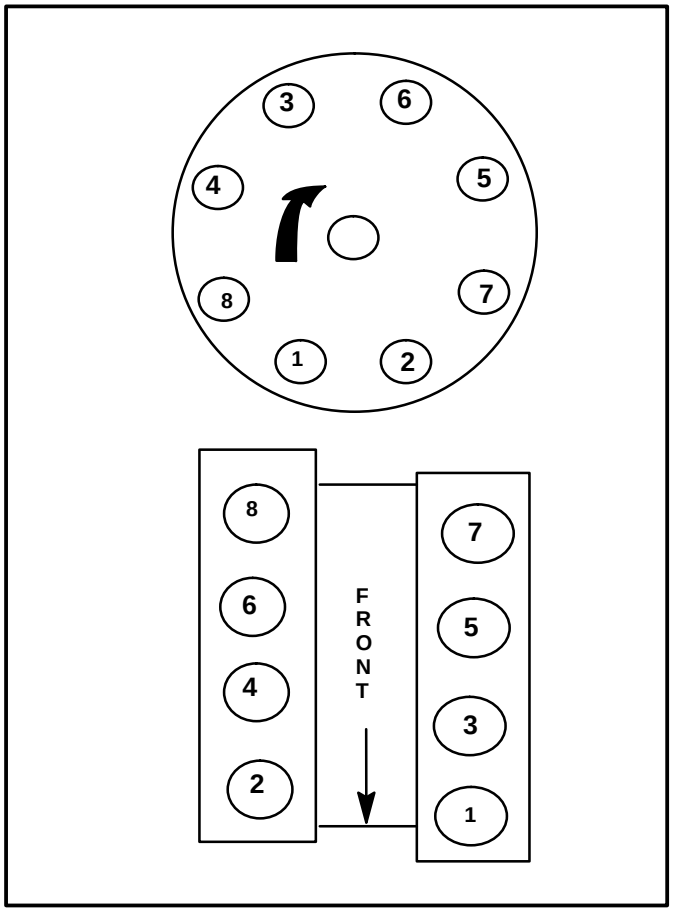
1. Install spark plugs. Torque to 11 lb. ft. (15 N·m).
2. Connect spark plug wires to their respective spark plug.

IMPORTANT: Wire routing must be kept intact during service and followed exactly when wires have been disconnected or when wire replacement is necessary. Failure to route wires properly can lead to radio frequency interference, cross firing of the plugs, and/or shorting of leads to ground.

NOTE: *When replacing spark plug wires, it is good practice to replace one wire at a time to reduce the risk of error.*

REMOVAL AND INSTALLATION

1. Disconnect one spark plug wire at spark plug and distributor.
2. Connect new spark plug wire at spark plug and distributor.
3. Continue steps 1 and 2 until all spark wires have been replaced.



Engine Rotation and Firing Order

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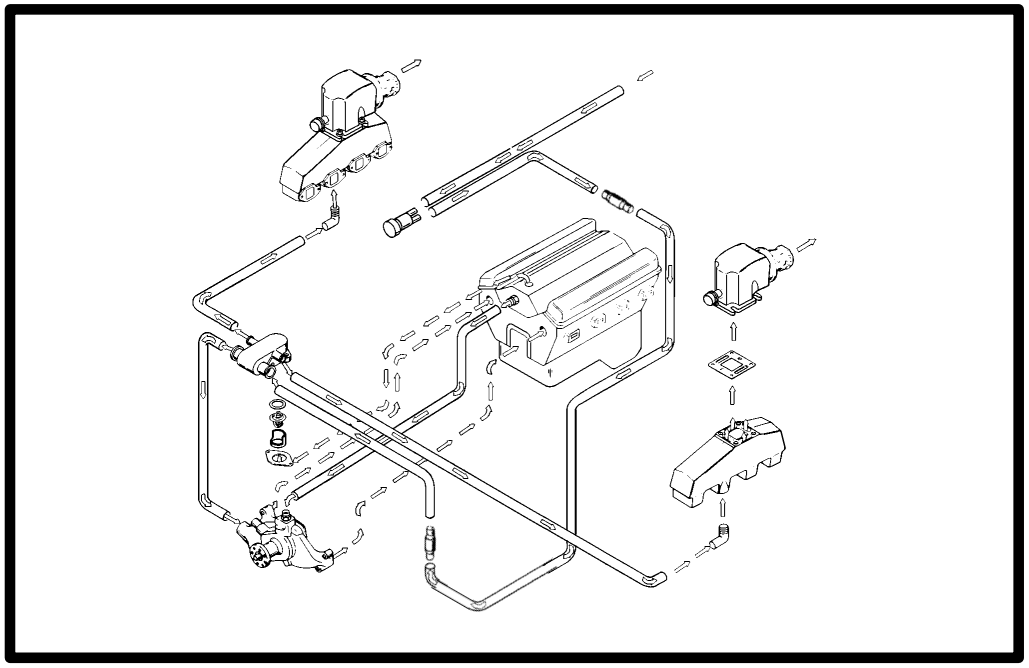
COOLING SYSTEM



SEAWATER COOLED MODELS

6
A

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Torque Specifications

Fastener Location	Lb. In.	Lb. Ft.	N·m
Alternator Brace To Alternator	192		28
Alternator Brace To Block	30		41
Alternator Mounting Bracket			
Power Steering Pump Brace To Block			
Power Steering Pump Bracket			
Seawater Pump Brace			
Seawater Pump Bracket To Block			
Seawater Pump Cover			
Thermostat Cover			
Thermostat Housing			
Thru-Hull Pickup Nut			
Alternator To Mounting Bracket	35		48
Water Circulating Pump			
Seawater Pump Clamping Screw On Casting Bracket	20		27
Water Temperature Sender			
Drain Plug (Note)	Securely		
Hose Clamps			
Petcocks			
Pulleys			

NOTE: *Coat threads with Quicksilver Perfect Seal before installing.*

Tools/Lubricants/Sealants

Description	Part Number
Universal Puller Plate	91-37241
Quicksilver Loctite 8831	92-823089-1
Quicksilver Perfect Seal	92-34227-1
Quicksilver 2-4-C Marine Lubricant With Teflon	92-825407A3
Quicksilver Flushing Attachment	73971A2
Pulley Puller (Kent Moore)	J-25034
Quicksilver High Performance Gear Lube	92-816026A
Quicksilver Liquid Neoprene	92-27511-2
Quicksilver Special Lubricant 101	92-13872A1
Loctite 514	92-75505-1
Silicone Sealant Or Equivalent	Obtain Locally
Shell Alvania No. 2 Grease	

Kent-Moore Tools, Inc.
29784 Little Mack
Roseville, MI 48066
Phone: (313) 574-2332

Specifications

Cooling System Capacity

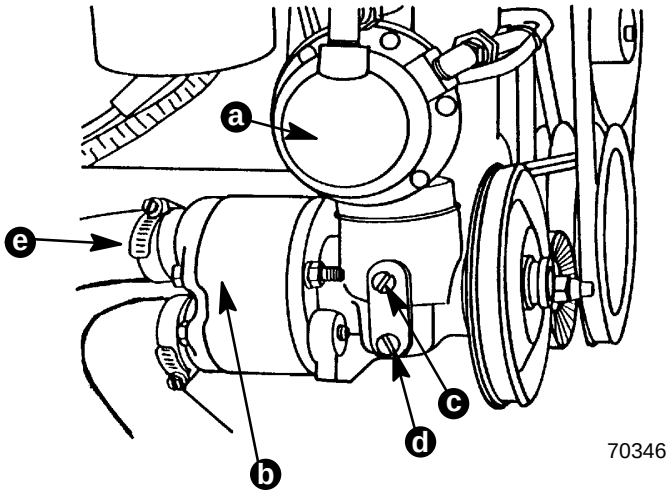
Engine	U.S. Qt. (L)
All	15 (14.1)

Thermostat

Engine	Specification
All Engines (Except Stainless Steel Thermostat Housing)	143°F (62°C)
Stainless Steel Thermostat Housing	160°F (71°C)

Identification

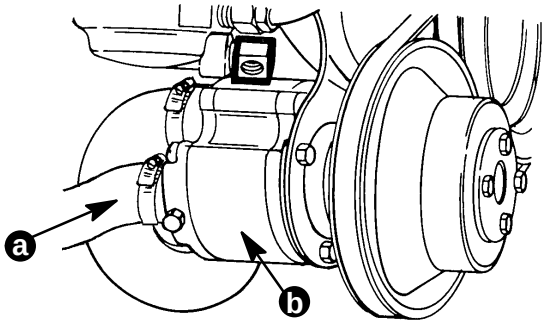
Combination Seawater / Mechanical Fuel Pump



70346

a - Fuel Pump
b - Seawater Pump
c - Vent Screw
d - Drain Screw, If Equipped
e - Inlet Hose

Seawater Pump With Cool Fuel System



72352

a - Inlet Hose
b - Seawater Pump

Seawater Inlet Recommendations

Transom Mounted or Thru-Hull Seawater Pickups and Hose

Water pickup must be large enough to permit sufficient water flow to engine seawater pickup pump for adequate engine cooling [30 gal. per min. (114 L per min.) minimum]. Pickup also must supply a positive head while underway.

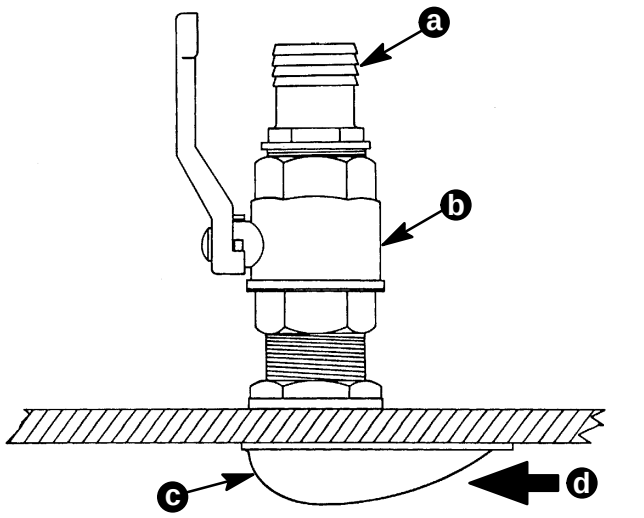
⚠CAUTION

Do not install water pickup directly in line with propeller, as pickup may create turbulence and allow air to flow into the "propeller slipstream." This will cause propeller ventilation and will adversely affect boat performance.

Water pickup should be located as close to seawater pickup pump inlet as possible and in an area where an uninterrupted, solid stream of water will flow past when boat is underway. Connect water pickup to seawater pickup pump inlet with 1-1/4 in. (32 mm) I.D. wire reinforced hose of adequate wall thickness to prevent it from collapsing from pump suction. Be sure to secure hose connections with hose clamps.

Seacock (Seawater Inlet Valve)

If a seacock is being used, it must be installed between water pickup and seawater pickup pump (or sea strainer), to allow operator to shut off the seawater in case of a leak or when boat is not in use. This will allow the operator to flush or drain the engine, or clean the sea strainer while boat is in the water. Seacock used must have an internal cross-sectional area equal to or greater than hose to prevent restricting water flow. Install seacock in an area where it will be easily accessible and self-supporting to prevent hose fatigue.



70355

Seacock (with Thru-Hull Pickup Shown)

a - Hose Connector 1-1/4 In. (32 mm) I.D. To Seawater Pump Inlet
b - Seacock 1-1/4 In. (32 mm) Brass Ball Or Gate Valve
c - Seawater Pickup
d - Direction Of Seawater Flow

Sea Strainer

If boat is equipped with a sea strainer, it must be of sufficient size to ensure that an adequate supply of water is maintained for engine cooling. Install seawater strainer in an area where it will be easily accessible for inspection and cleaning. Strainer should be installed in water inlet hose after water inlet valve to allow operator to shut off water when cleaning strainer.

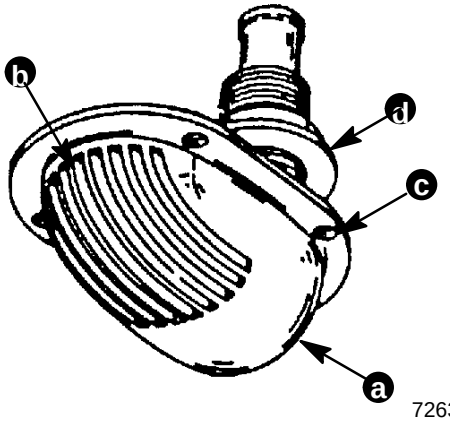
Seawater Pickups

NOTICE

Refer to manufacturer's instructions for information on removal and installation of other than Quicksilver Seawater Pickups.

IMPORTANT: Seal the inside edges of any hole made through the hull with a suitable sealant to prevent water absorption and deterioration.

Thru-Hull Mounted



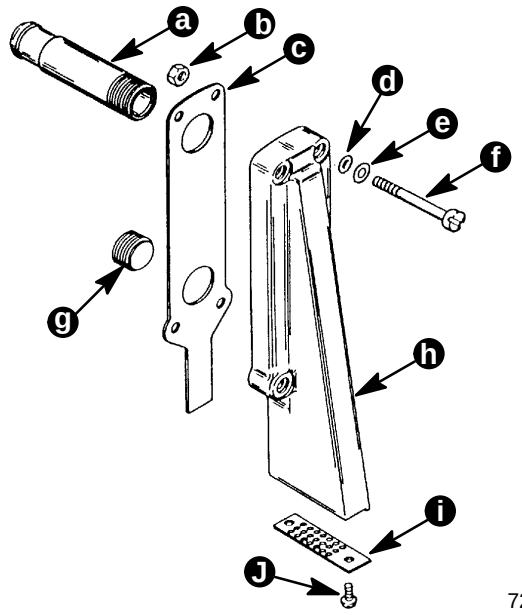
72639

a - Seawater Pickup
b - Seawater Inlet Slots (Must Face Forward - Parallel With Water Flow
c - Mounting Screw Holes (If Equipped)
d - Nut

1. Seal inside edges of 1-3/4 in. (44 mm) hole in hull using a suitable sealer.
2. Apply marine caulking (sealer) to mounting surface on seawater pickup where hull contact will occur when installed.
3. Ensure slots in seawater pickup are facing forward (toward bow of boat) and install seawater pickup through hull. The slots must be parallel with flow of water.
4. Fasten pickup with four appropriate mounting screws (if so designed).
5. Apply marine caulking as needed inside boat. Apply Loctite to threads of nut and install on pickup on inside of boat and torque nut to 35 lb. ft. (42 N·m).

NOTE: *If pickup being installed does not have mounting screws on underside where mounted to hull, be certain, after nut is torqued, that slots are still facing forward.*

Transom Mounted



72640

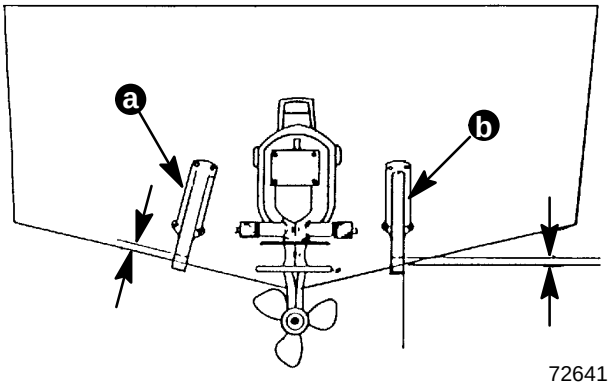
a - Hose Nipple
b - Nut (4)
c - Gasket - Between Pickup and Transom
d - O-Ring (4)
e - Washer (4)
f - Screw (4)
g - Plastic Pug
h - Pickup
i - Screen
j - Screw (2)

1. Seal the inside edges of the 1-1/2 in. (38 mm) hole hose nipple.
2. Be certain hose nipple and plastic plug are in place and threads have been sealed with Loctite Pipe Sealant with Teflon prior to tightening each securely.

NOTE: *Use a sharp knife or wood chisel to remove excess plastic plug material so that plug is flush with pickup casting.*

3. Position one flat washer and one rubber O-ring on each 5/16 in. x 4 in. (102 mm) long, round head screw as shown. Coat each screw shaft with silicone sealant or equivalent.
4. Place new gasket on pickup housing and hold pickup in place on transom. Install four round head screws (with washers and O-rings in place) into pickup mounting holes and through drilled 21/64 in. (8.4 mm) holes in transom.

NOTE: *Some installations may have 7/32 in. (5.6 mm) holes drilled in transom using four 5/16 in. diameter stainless steel lag bolts in place of round head screws. In any case, flat washers and O-rings are required as outlined.*



72641

Water Pickup Installed on Transom

a - Diagonal Mount - Leading Edge Of Pickup 1/8 In. (3.2 mm) From Boat Bottom.
b - Vertical Mount - Corner Of Leading Edge Of Pickup 1/8 In. 3.2 mm) From Boat Bottom

5. Secure water pickup from inside with locknuts and washers (unless using lag bolts).
6. Tighten fasteners securely.

Sea Strainer (Quicksilver)

NOTICE

Refer to manufacturer's instructions for information on removal and installation of other than Quicksilver Sea Strainer.

Removal

⚠CAUTION

If boat is in water while working on seawater strainer, close seacock, if so equipped. If boat is not equipped with a seacock, remove and plug seawater inlet hose to prevent a siphoning action that may occur, allowing seawater to flow from the drain holes or removed hoses and enter boat.

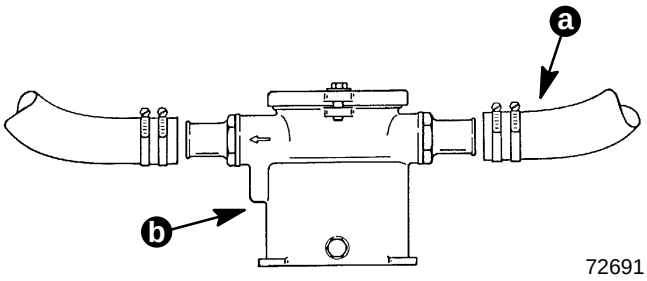
IMPORTANT: Be certain engine is off and cooling system is cold.

1. Follow “a” or “b” instructions:

   a. **Models Equipped with Seacock:**

      (1) Close seacock (seawater inlet valve).

      (2) Disconnect seawater inlet hose from seawater strainer.

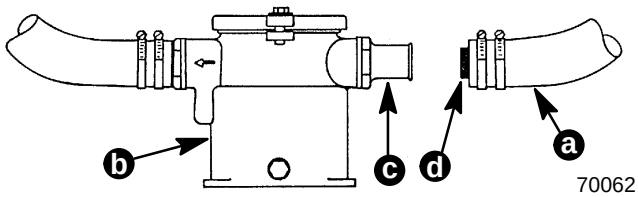


72691

a - Seawater Inlet Hose
b - Seawater Strainer

   b. **Models without Seacock:**

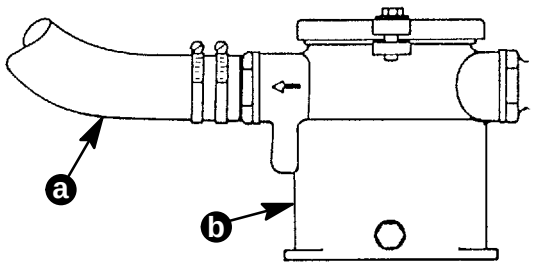
      (1) Disconnect seawater inlet hose from seawater strainer inlet and plug seawater inlet hose.



70062

a - Seawater Inlet Hose
b - Seawater Strainer
c - Seawater Strainer Inlet
d - Plug

2. Remove outlet hose. Drain into a suitable container.



72643

a - Seawater Inlet Hose
b - Seawater Strainer

3. Remove mounting bolts. Remove strainer.

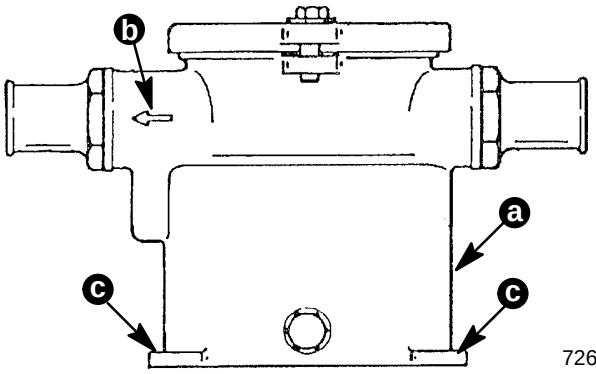
Installation

IMPORTANT: Mount seawater strainer in a vibration-free location. Never mount it on the engine or transmission. Hoses must not be kinked or allowed to come in contact with hot or moving engine or transmission parts.

1. Mount seawater strainer.

   Arrow indicates required water flow direction and must point toward seawater pump.

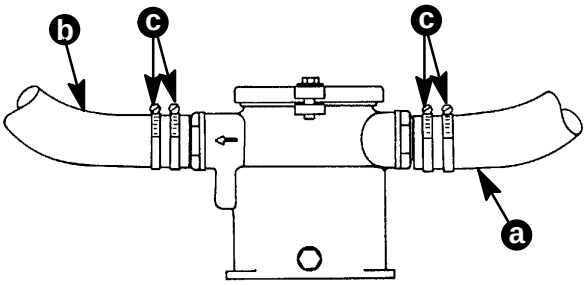
   Tighten mounting bolts securely.



72644

a - Seawater Strainer
b - Arrow
c - Mounting Bolt Hole Location (Bolts Not Shown)

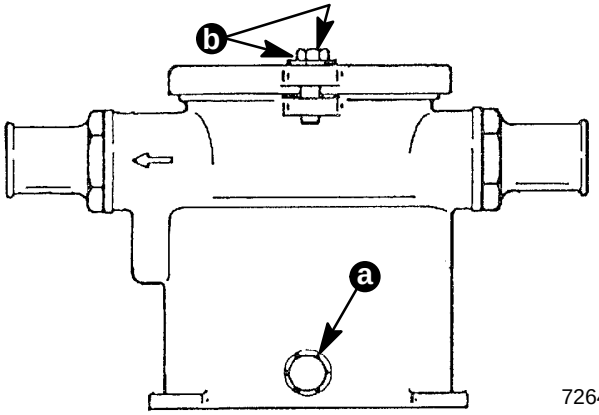
2. Remove plug from seawater inlet hose (if installed previously) and install hose on strainer. Install seawater outlet hose. Use two hose clamps on each hose connection. Tighten clamps securely.



72645

a - Seawater Inlet Hose
b - Seawater Outlet Hose
c - Double Hose Clamps

3. Check drain plug and lens cover bolts. Tighten securely. Do not over-tighten cover bolts or cover may warp and leak water into boat.



a - Drain Plug
b - Lens Cover Bolts (2, One Hidden In This View)

4. Open seacock, if equipped.

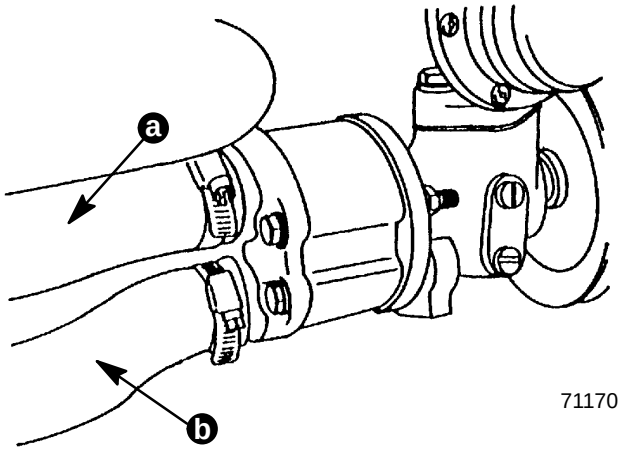
Seawater Pickup Pump Output Test

If an overheating problem exists, use this test to determine if a sufficient amount of water is being supplied to cool engine.

IMPORTANT: The following information should be observed before proceeding with test:

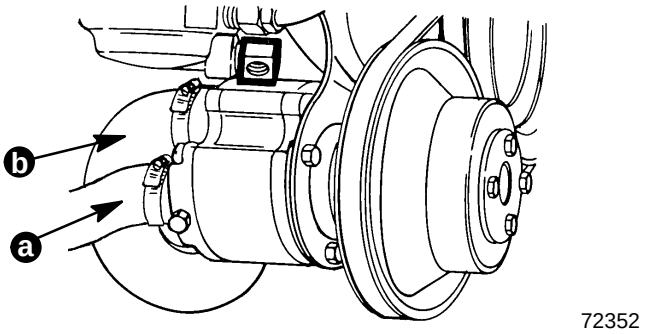
- **BOAT MUST BE IN THE WATER FOR THIS TEST. This test CANNOT BE performed with a flush-test device and water hose.**
- **The ability of this test to detect a problem is greatly dependent upon the accuracy in which it is performed. An error in setting the engine RPM, timing the test or measuring the water output will affect the overall accuracy of the test and may produce misleading results. To help ensure accurate results, a shop tachometer with an error of less than 5% should be used. The boat tachometer definitely should not be used as its accuracy is questionable. A stop watch should be used to time the duration of the test to help ensure that the accuracy is maintained within one second. An 8 qt. (7.6 L) or larger capacity container should be used to measure water output.**
- **Due to the manner in which this test is performed, it may not be possible to detect a marginal condition or a high-speed water pump output problem.**

1. Remove water hose, which runs between pump outlet and engine, and replace with another hose of same diameter, but approximately 3 ft. (1 m) longer. Hose should be wire reinforced or of adequate wall thickness to prevent it from kinking when performing test. Clamp hose at pump outlet only. Do not clamp hose at engine end.



Engines With Combination Seawater / Mechanical Fuel Pump

a - Seawater Inlet Hose
b - Hose To Cooler



Engines WIth Cool Fuel System

a - Seawater Inlet Hose
b - Hose To Cooler

2. Place an 8 qt. (7.6 L) or larger container near unclamped end of hose.

⚠CAUTION

Do not run engine for more than 15 seconds with hose disconnected, in next step, as internal damage to engine and exhaust system may result.

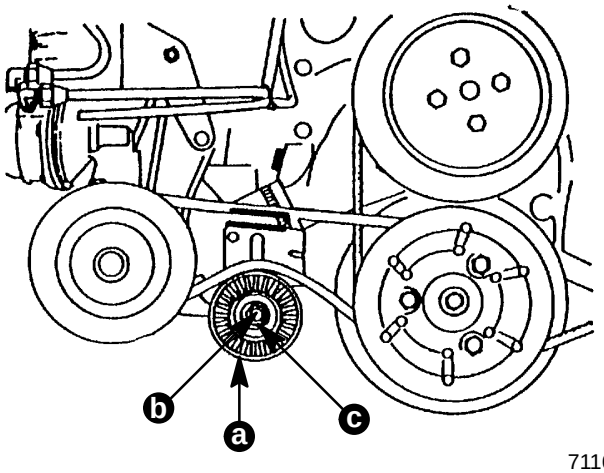
3. With assistance of another person, start engine and adjust speed to exactly 1000 RPM while holding unclamped end of hose on connection on engine. Remove hose from connection on engine and direct water flow into container for exactly 15 seconds. At the end of 15 seconds, direct the water flow overboard, return engine to idle and stop engine. Reconnect hose to engine.
4. Measure quantity of water discharged into container and compare with specifications given in chart following.
5. Repeat test four times to check repeatability of results.

Belt Driven Pump Output For a 15 Second Period
7.5 U.S. Qt. (7.1 L) Minimum

Belt Driven Combination Seawater/Fuel Pump

Removal

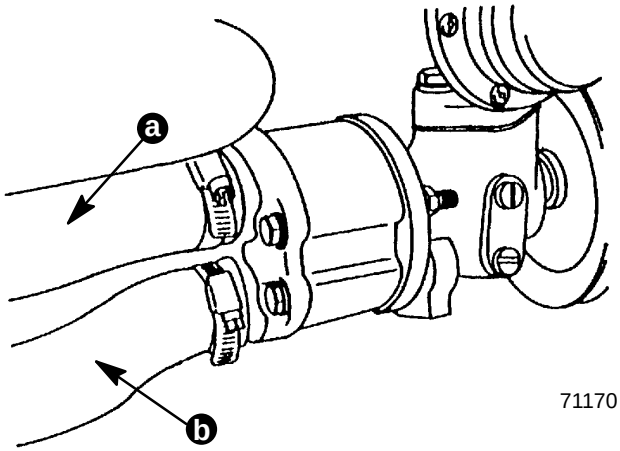
1. Remove drive belt by loosening idler pulley.



71167

a - Idler Pulley
b - Adjusting Bolt
c - Locknut

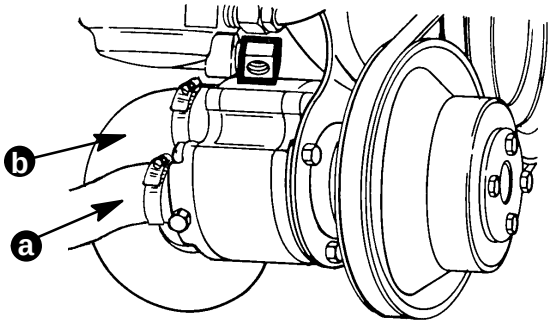
2. Disconnect water hoses from seawater pump.



71170

Engines With Combination Seawater / Mechanical Fuel Pump

a - Seawater Inlet Hose
b - Hose To Cooler



72352

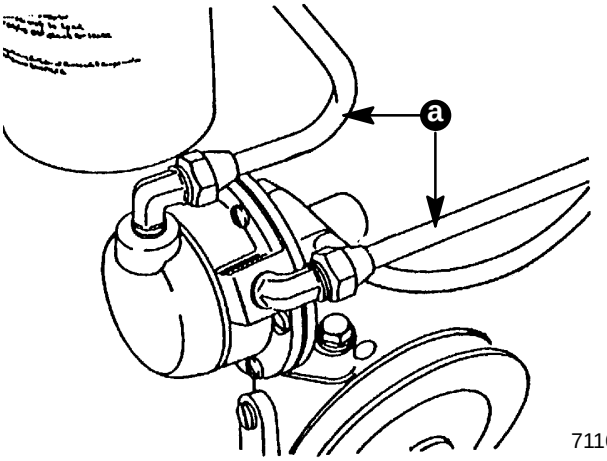
Engines WIth Cool Fuel System

a - Seawater Inlet Hose
b - Hose To Cooler

⚠ WARNING

Be careful when working on fuel system components. Gasoline is extremely flammable under certain conditions. Be sure ignition key is OFF. Do not smoke or allow spark or open flame in area when working on fuel system components. Wipe up any spilled fuel immediately.

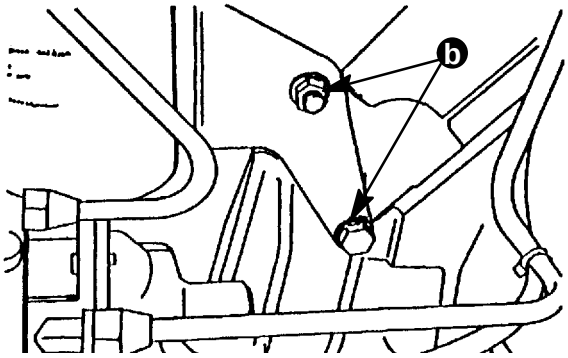
3. Disconnect fuel lines from fuel pump.



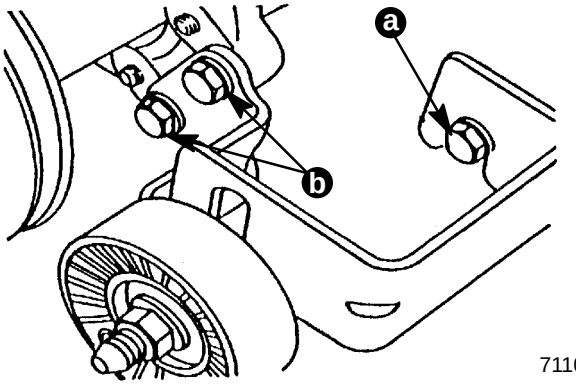
71169

a - Fuel Lines

4. Remove seawater/fuel pump assembly.



71161



71102

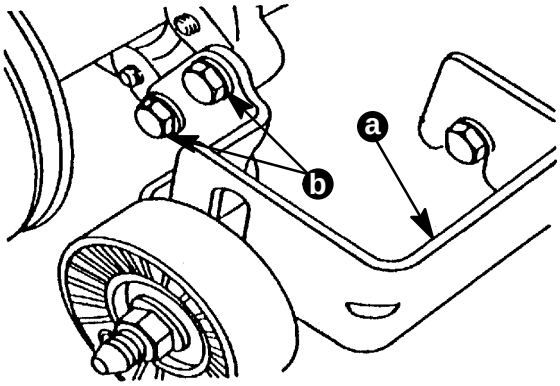
a - Idler Bracket Bolt
b - Main Bracket Bolts (2)

Disassembly

NOTE: *Later models may be equipped with a one piece seawater pump body. Disassembly will be similar to two piece seawater pump body but reassembly will differ in certain areas.*

IDLER PULLEY ASSEMBLY

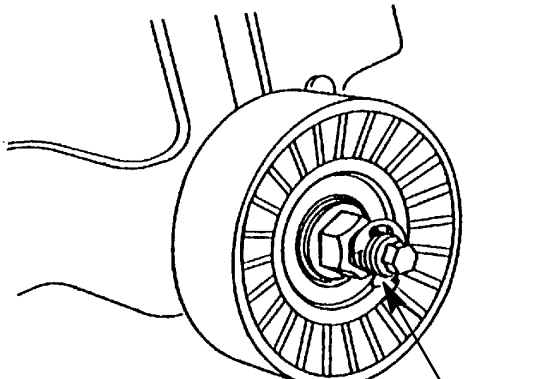
1. Remove idler pulley bracket from pump housing.



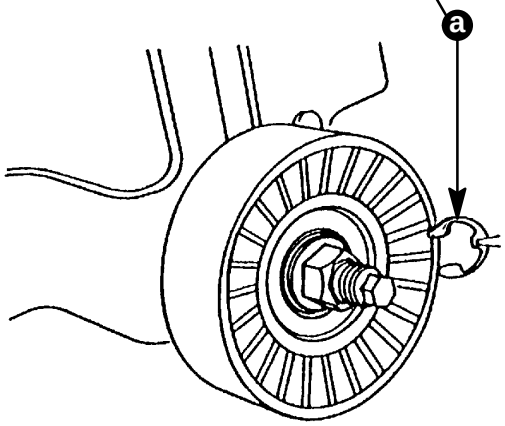
71102

a - Bracket
b - Main Bracket Bolts (2)

2. Remove retaining clip from adjusting bolt.



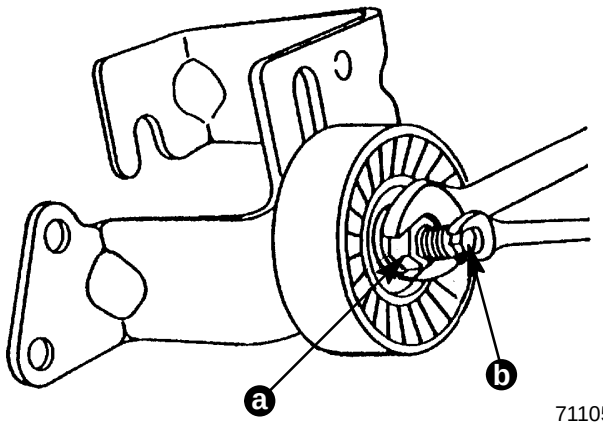
71103



71104

a - Retaining Clip

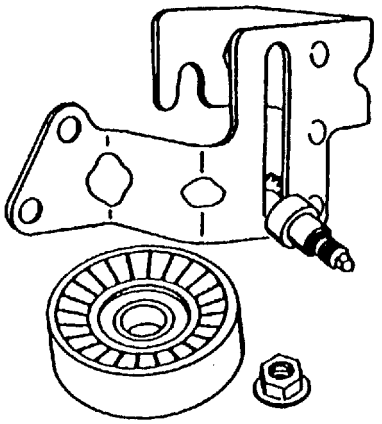
3. Loosen locknut while holding adjusting bolt.



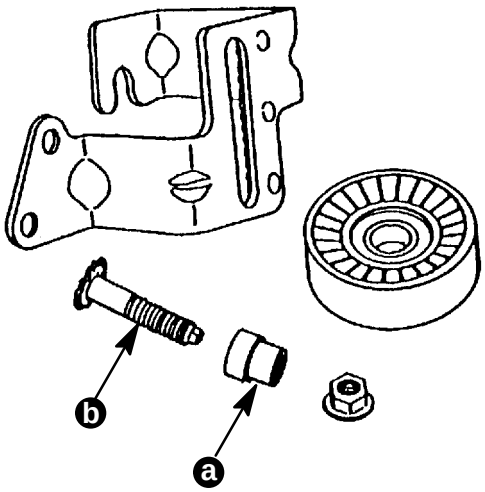
71105

a - Locknut
b - Adjusting Bolt

4. Remove idler pulley, bushing and adjusting bolt.



71106



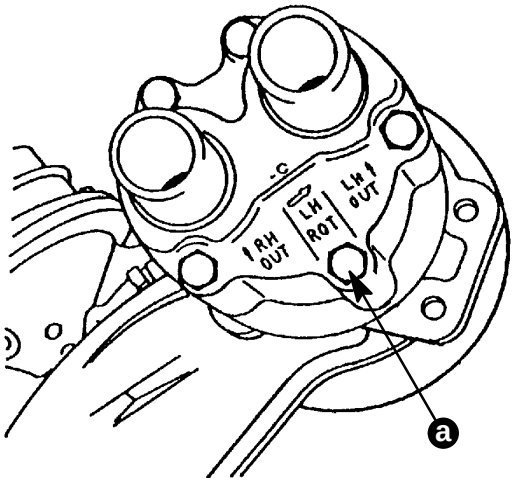
71107

a - Bushing
b - Adjusting Bolt

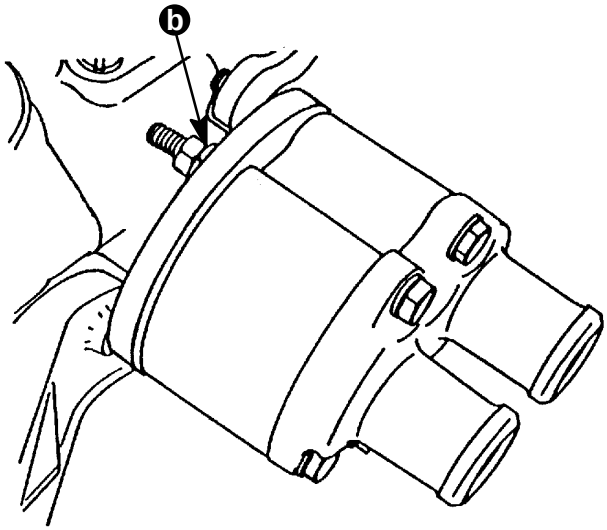
SEAWATER PUMP DISASSEMBLY (TWO PIECE BODY)

1. Loosen bolts that secure water pump to housing.

NOTE: *One of these bolts is secured with a nut and lockwasher.*



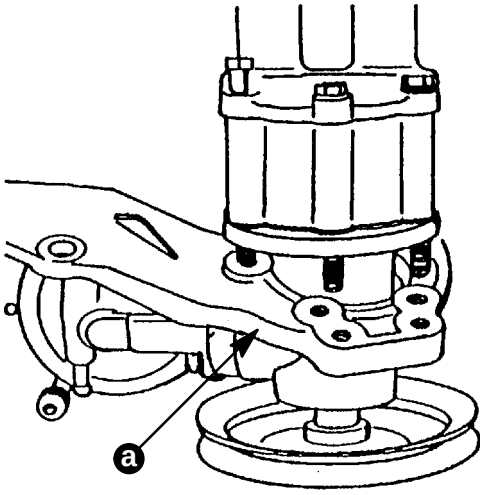
71108



71109

a - Bolts (5)
b - Nut and Lockwasher

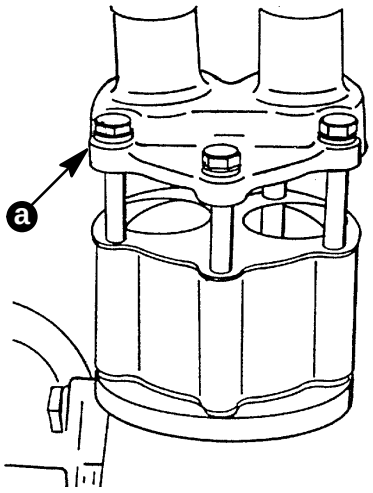
2. Remove bracket from pump housing.



71110

a - Bracket

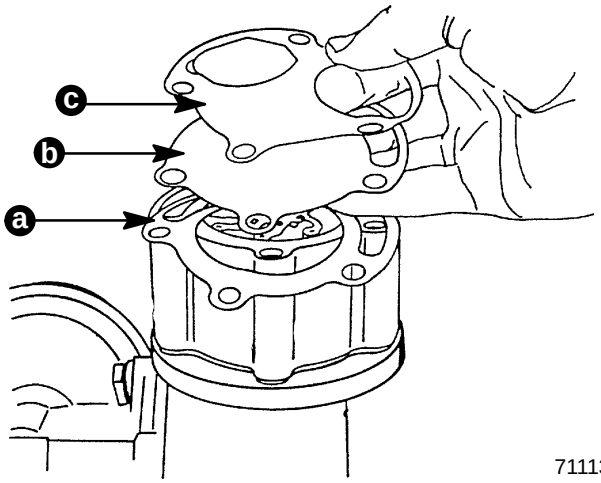
3. Remove water pump end cover from housing.



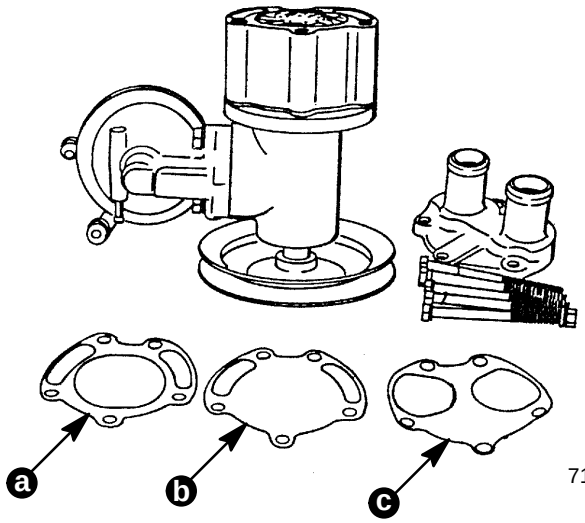
71112

a - End Cover

4. Remove gaskets and separator plate.



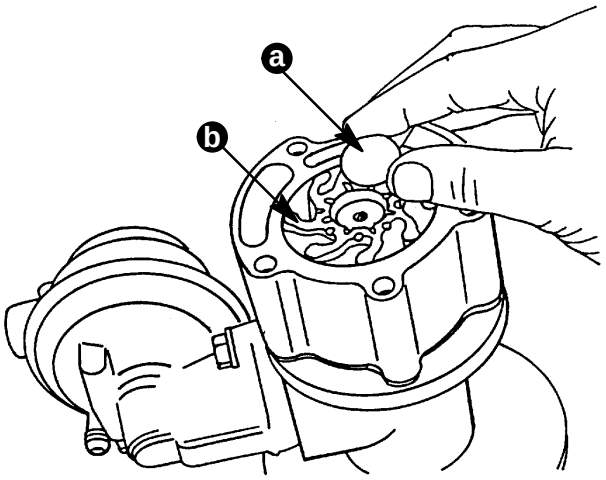
71113



71114

a - Gasket (With Large Opening)
b - Separator Plate
c - Gasket (With Two Opening)

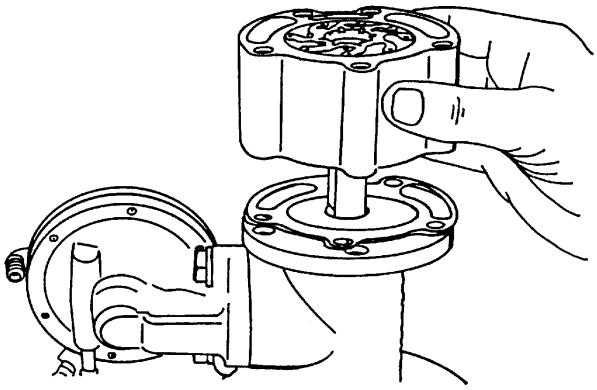
5. Remove rubber plug from end of impeller.



71115

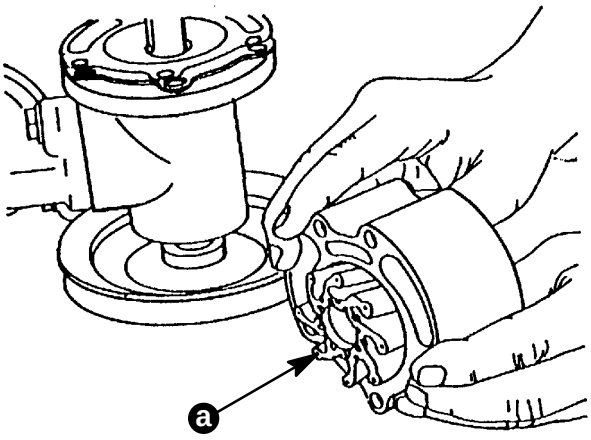
a - Rubber Plug
b - Impeller

6. Lift pump housing off of pump base.

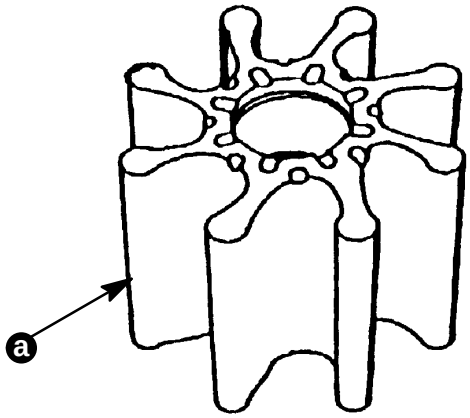


71116

7. Remove impeller from housing.



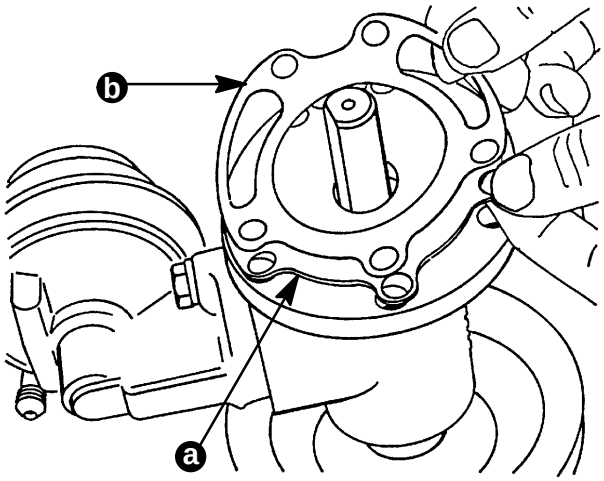
71117



71118

a - Impeller

8. Remove end plate and gasket from pump base.

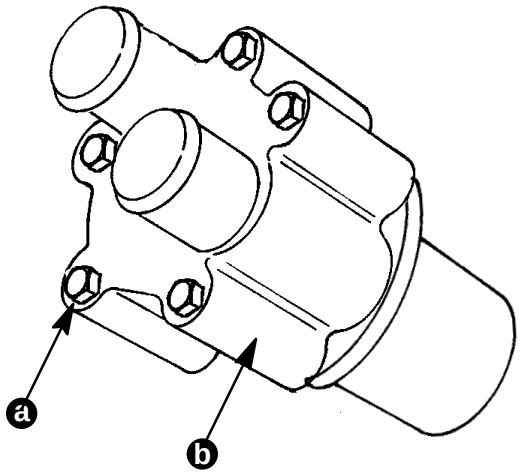


71119

a - End Plate
b - Gasket

SEAWATER PUMP DISASSEMBLY (ONE PIECE BODY)

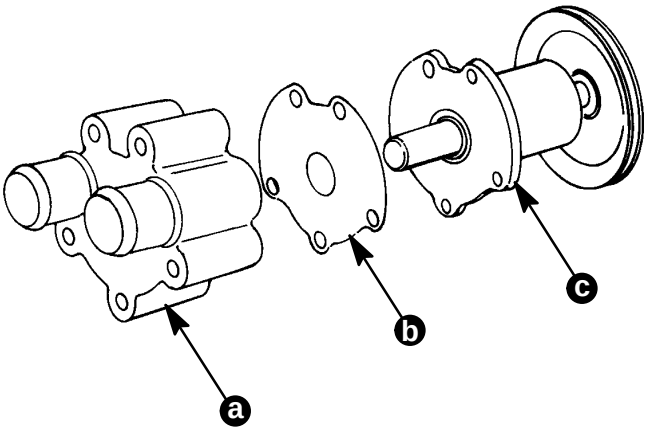
1. Remove the five screws from the seawater pump body.



75277

a - Screws (5)
b - Seawater Pump Body

2. Remove seawater pump body and wear plate from bearing housing.



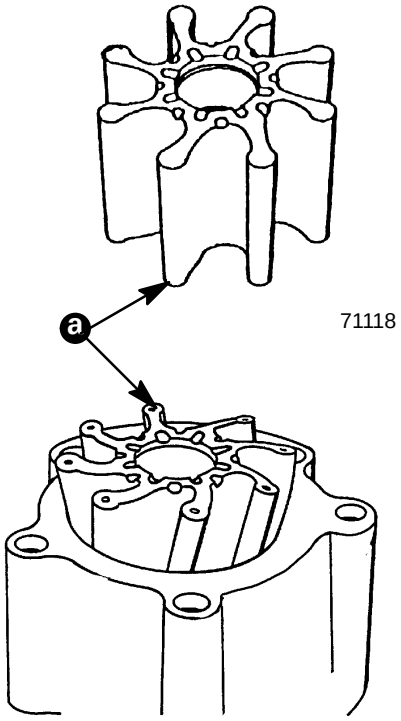
75275

a - Seawater Pump Body
b - Wear Plate
c - Bearing Housing

3. Remove the impeller from seawater pump body.

SEAWATER PUMP REASSEMBLY (ONE PIECE BODY)

1. Lubricate seawater pump impeller with a water and soap solution. Install impeller into housing by rotating and pushing it into place. Push it down until flush with housing.

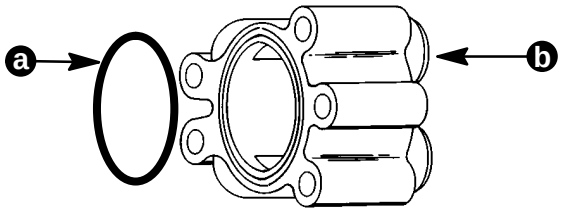


71118

71150

a - Impeller

2. Place wear plate over bearing housing shaft.
3. Place quad ring in groove in seawater pump body.

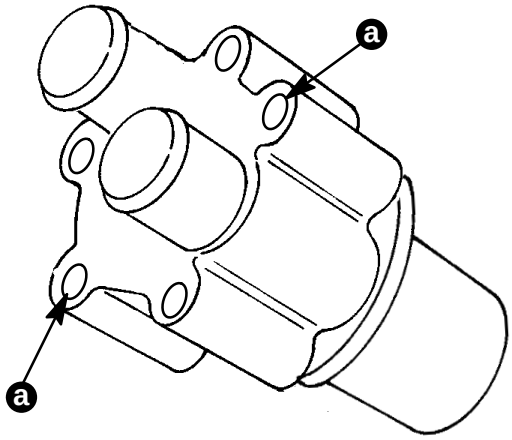


a - Quad Ring
b - Seawater Pump

4. Align flats on impeller and bearing housing shaft, slide seawater pump body on shaft.

NOTE: *Reassembly for the combination mechanical fuel pump requires the mounting bracket to be installed while performing the following step.*

5. Install two screws in seawater pump body holes as shown. Use these two screws to align pump, then install the remaining screws.

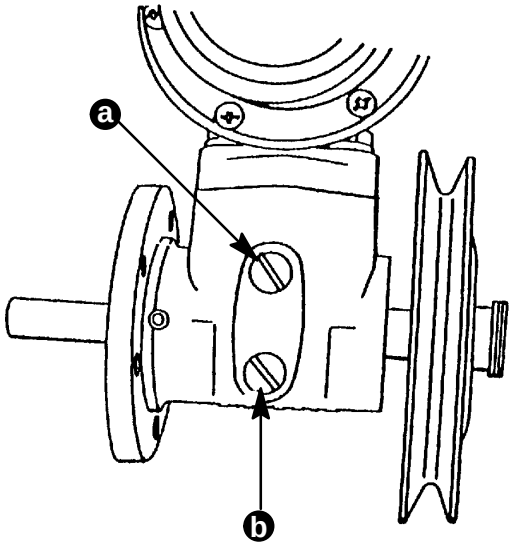


75277

a - Bolt Holes For Alignment

FUEL PUMP ASSEMBLY

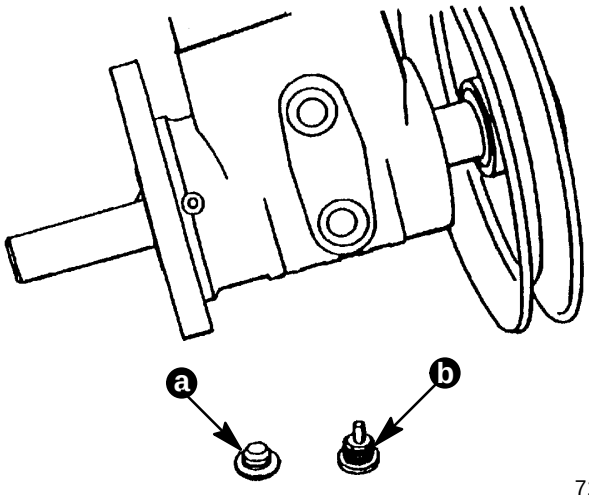
1. Remove fill and drain screws with sealing washers from pump housing and drain lubricant.



71120

a - Fill Screw
b - Drain Screw

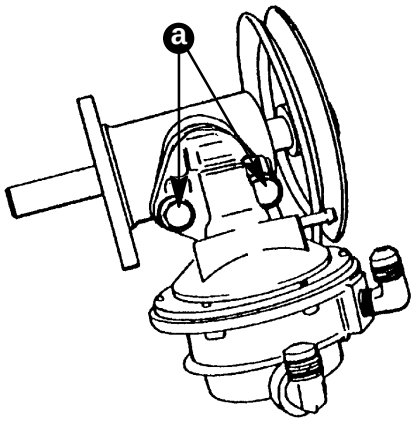
IMPORTANT: Drain screw is equipped with a magnet to attract metallic particles from inside of housing. A small amount will be present as a result of normal wear. Larger amounts of metallic particles may indicate abnormal wear.



71121

a - Fill Screw
b - Drain Screw (Magnet)

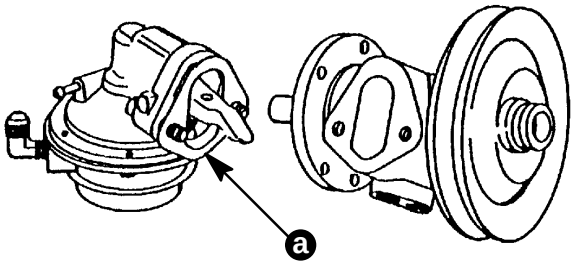
2. Remove fuel pump from housing.



71122

a - Bolts and Lockwashers (2)

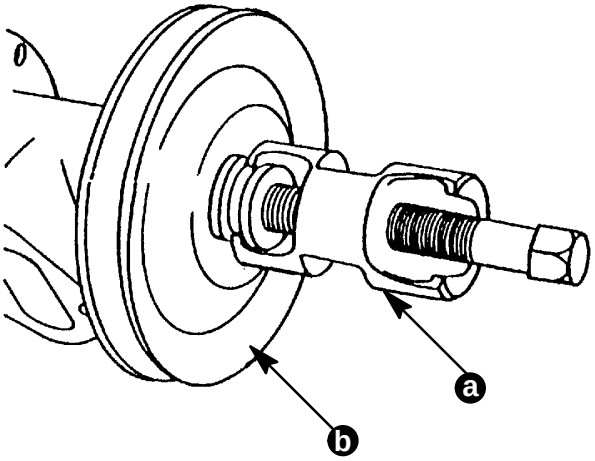
3. Remove fuel pump from housing and remove gasket.



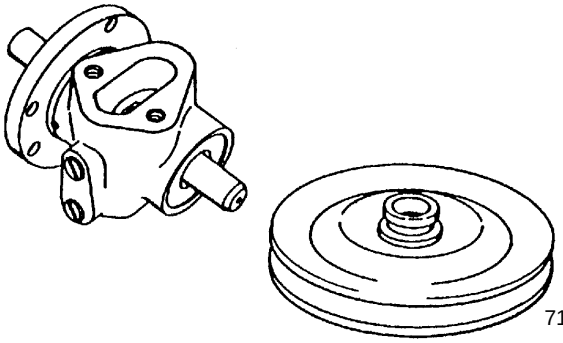
71123

a - Gasket

4. Remove pulley using appropriate puller.



71126

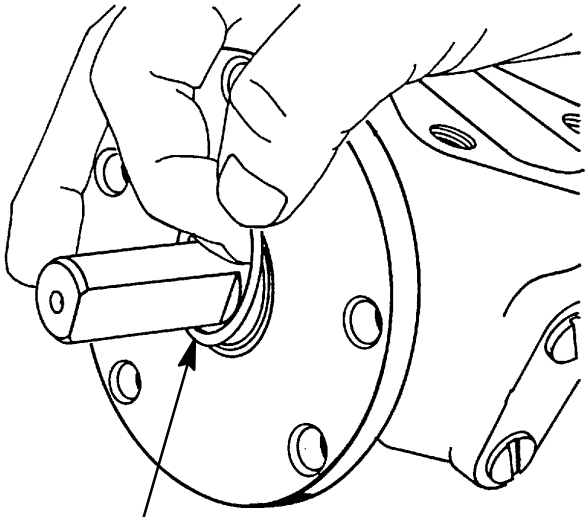


71127

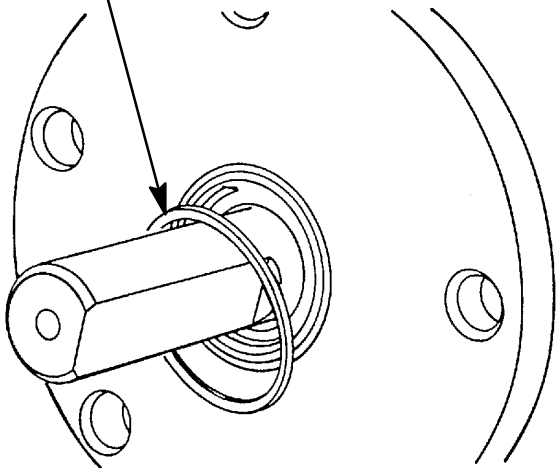
a - Puller
b - Pulley

SEAWATER/FUEL PUMP HOUSING

1. Remove quad ring seal from water pump end of housing.



71128

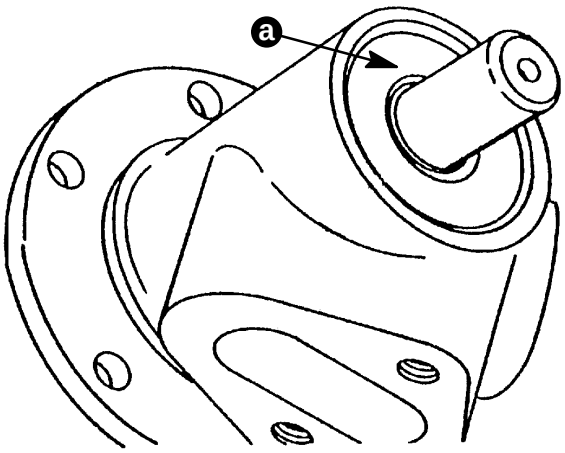


71129

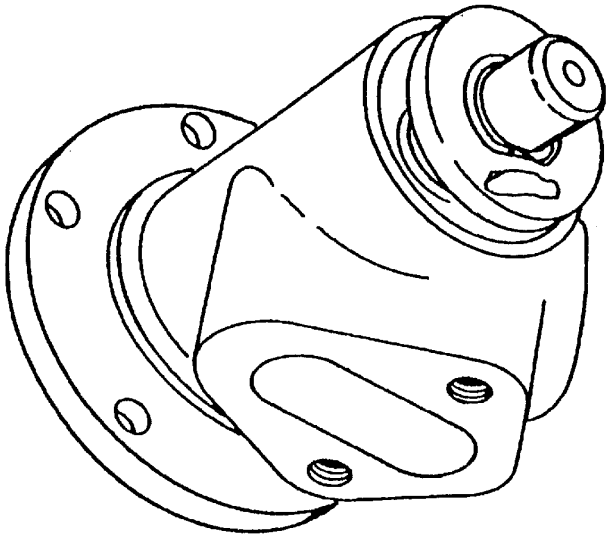
a - Quad Ring Seal

IMPORTANT: Oil seal on pulley end of housing will be damaged during removal. Do not attempt to reuse seal.

2. Remove oil seal by prying out with a screwdriver. Be careful not to damage bore.



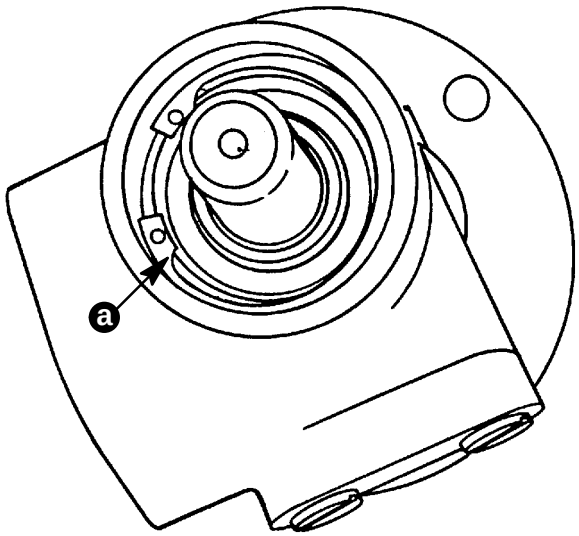
71130



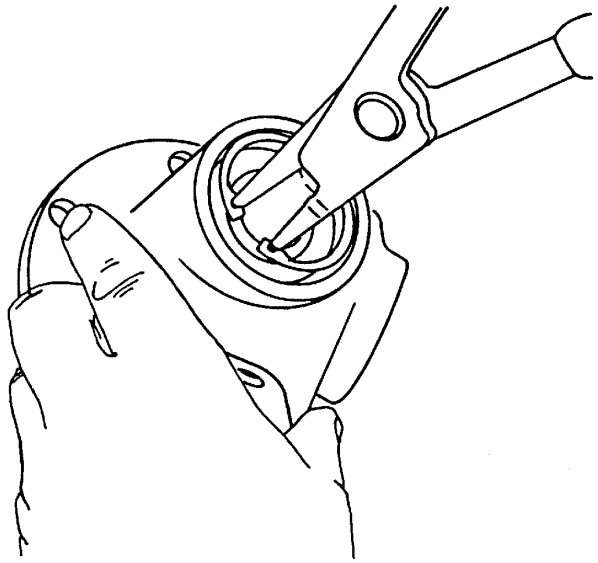
71131

a - Oil Seal

3. Remove the snap ring that secures the shaft and bearing assembly.



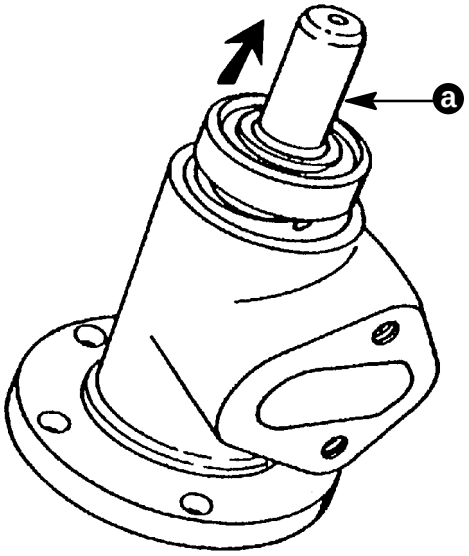
71132



71133

a - Snap Ring

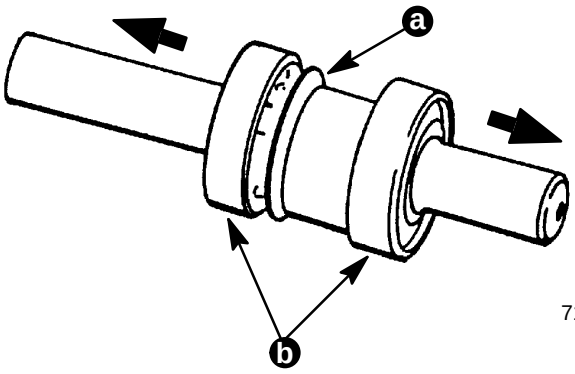
4. Lift shaft and bearing assembly from housing.



71134

a - Shaft and Bearing Assembly

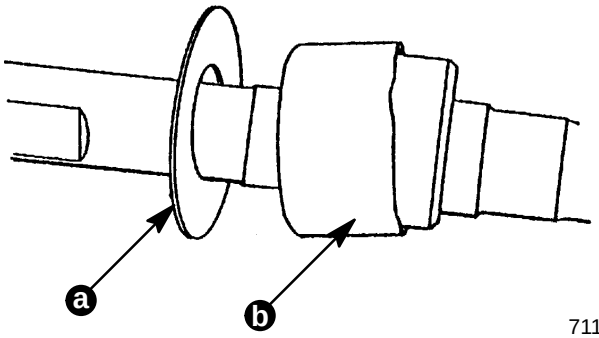
5. Remove bearings from shaft using a universal puller plate.



71139

a - Washer
b - Bearings

6. Slide washer and slip ring off of shaft.

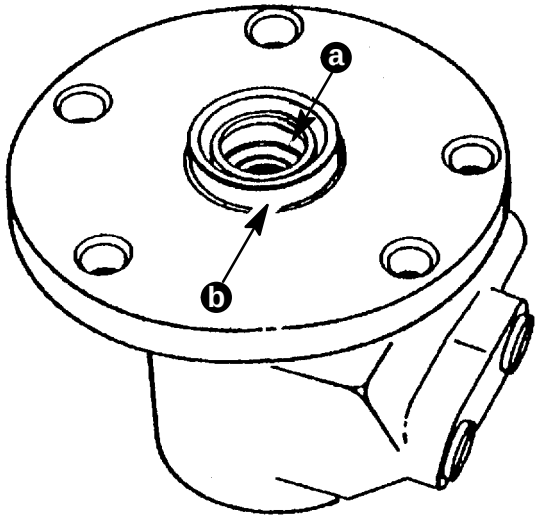


71141

a - Washer
b - Slip Ring

IMPORTANT: Oil and water seals on water pump end of housing will be damaged during removal. Do not attempt to reuse these seals.

7. Remove outer (water) seal and inner (oil) seal by prying out or by tapping out using a suitable mandrel. Be careful not to damage bore.



71142

a - Inner Oil Seal
b - Outer Water Seal

Cleaning and Inspection

⚠CAUTION

Always wear safety glasses when using compressed air.

1. Clean metal parts in solvent and blow dry with compressed air.

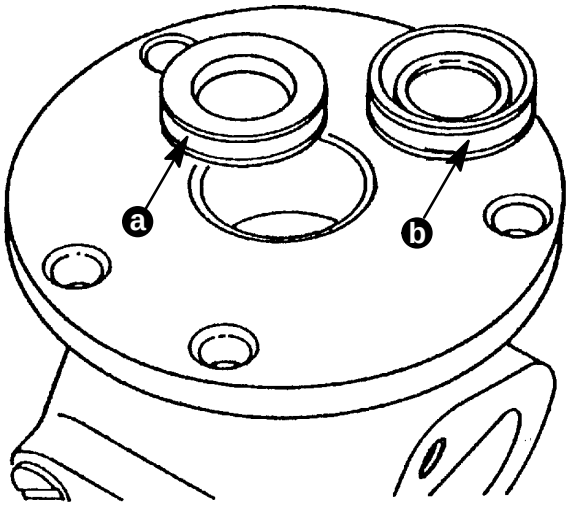
IMPORTANT: Do not spin bearings at high speed when drying with compressed air, as bearings may be scored.

2. After cleaning, apply a coat of light engine oil to shaft and bearings to prevent rust.
3. Clean all gasket material and sealer from sealing surfaces.
4. Inspect bearing housing. Examine surfaces (where bearings contact housing) for evidence of bearing outer races turning in housing.
5. Inspect seals in bearing housing.
6. Inspect pump shaft bearings.
7. Inspect pump shaft for grooves in surface where seals contact shaft. Inspect keyway in shaft. Also, inspect surface, where bearings contact shaft, for evidence of inner races turning on shaft.
8. Inspect impeller drive key.
9. Inspect pump body.
10. Inspect inner and outer wear plate.

Reassembly

SEAWATER/FUEL PUMP HOUSING

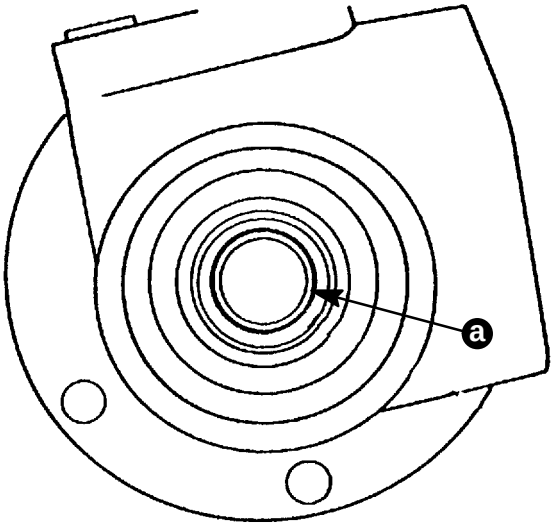
IMPORTANT: Seals in water pump end of housing must be facing in the proper direction. The lip on inner (oil) seal must be facing inward toward oil pump. The lip on outer (water) seal must be facing outward toward the water pump.



71143

a - Inner Oil Seal - Lip Inward Toward Oil Pump
b - Outer Water Seal - Lip Outward Toward Water Pump

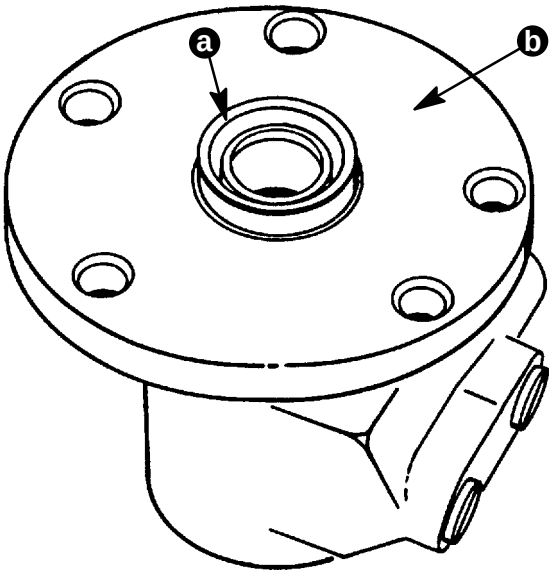
1. Apply a light coat of Loctite 514 to O.D. of seal and install inner (oil) seal using a suitable mandrel. Seal is properly positioned when edge of seal is even with edge of bore.



71144

a - Inner Oil Seal

2. Apply a light coat of Loctite 514 to O.D. of seal and install outer (water) seal using a suitable mandrel. Seal is properly positioned when edge of seal is flush with face of housing. Do not install seal deeper. Fill cavity between the two seals with Quicksilver Special Lubricant 101.



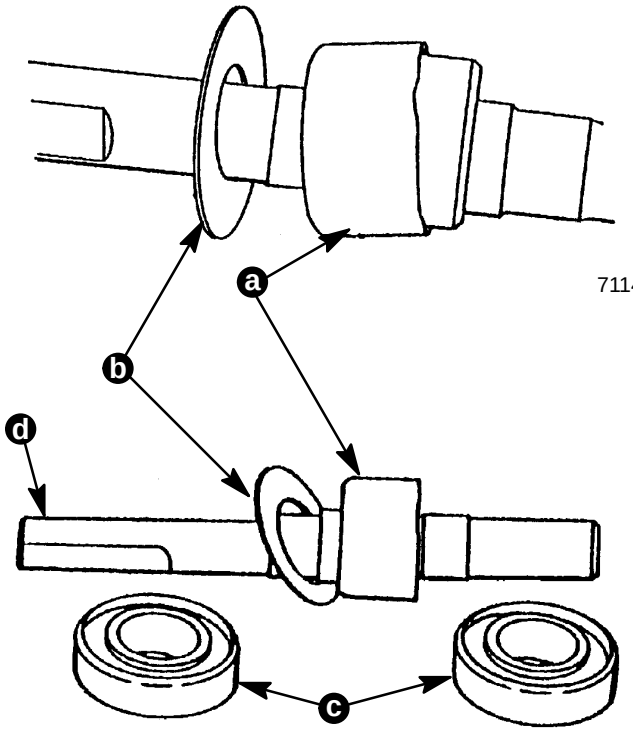
71145

a - Outer Water Seal
b - Face Of Housing

3. Reassemble shaft and bearing assembly as follows:

   a. Lubricate all shaft components and bearings with Quicksilver High Performance Gear Lube.

   b. Place slip ring and washer over shaft from water pump impeller end.

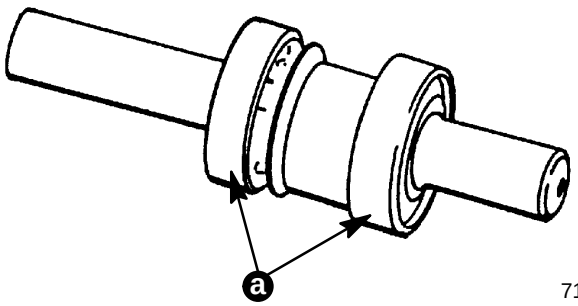


71141

71140

a - Slip Ring
b - Washer
c - Bearings
d - Water Pump Impeller End

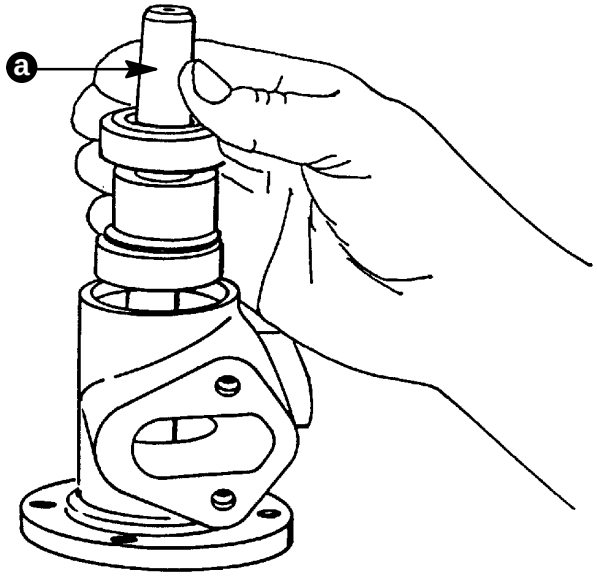
   c. Press bearings onto shaft until seated.



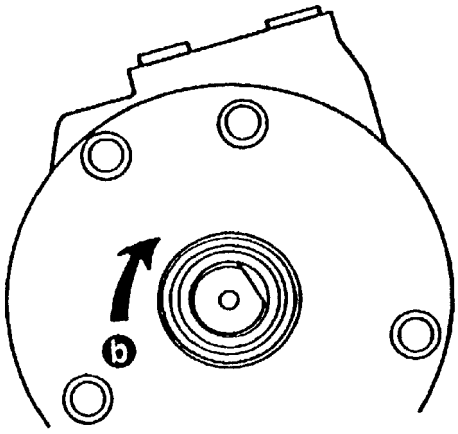
71139

a - Bearings

4. Lower shaft and bearing assembly onto housing. Use care when guiding shaft through oil and water seals to avoid turning over seal lips. To avoid this, rotate shaft as it is lowered through seals.



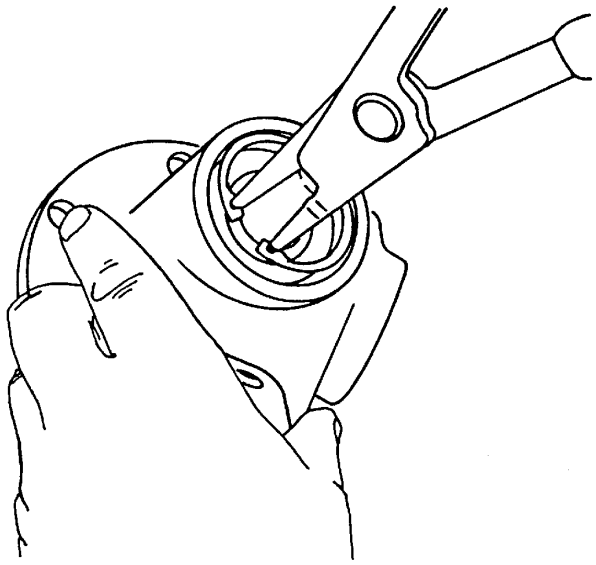
71146



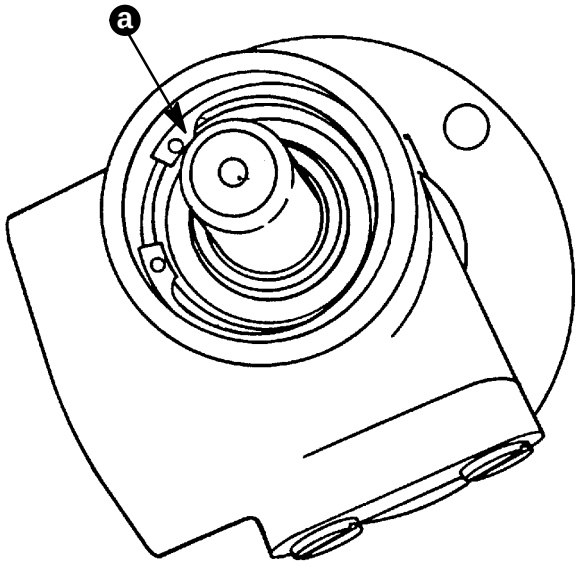
71147

a - Shaft and Bearing Assembly
b - Rotate When Moving Through Seals

5. Push shaft and bearing assembly down until seated. Shaft is properly seated when the snap ring groove is visible above the outer bearing.
6. Install snap ring to secure shaft and bearing assembly.



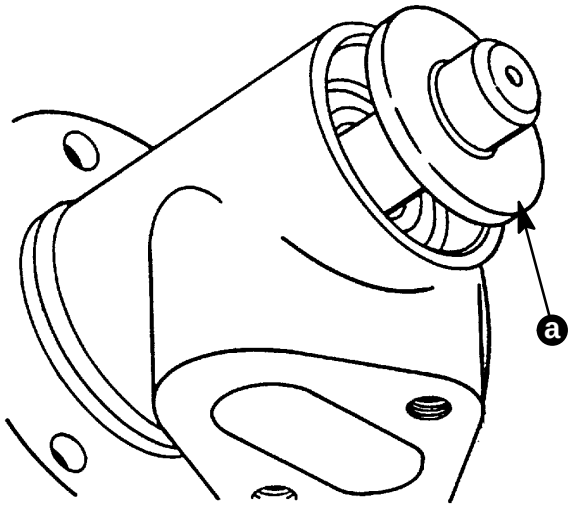
71133



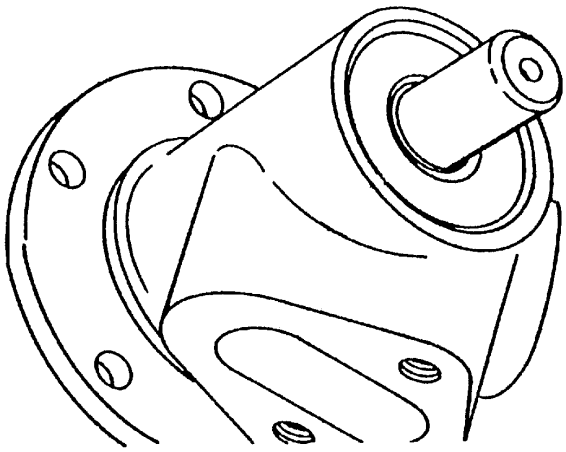
71132

a - Snap Ring

7. Apply a light coat of Loctite 514 to O.D. of seal and install oil seal on pulley end of housing using a suitable mandrel. Seal lip should be facing inward toward snap ring. Lubricate lip of seal with Quicksilver Special Lubricant 101. Seal is properly positioned when it bottoms.



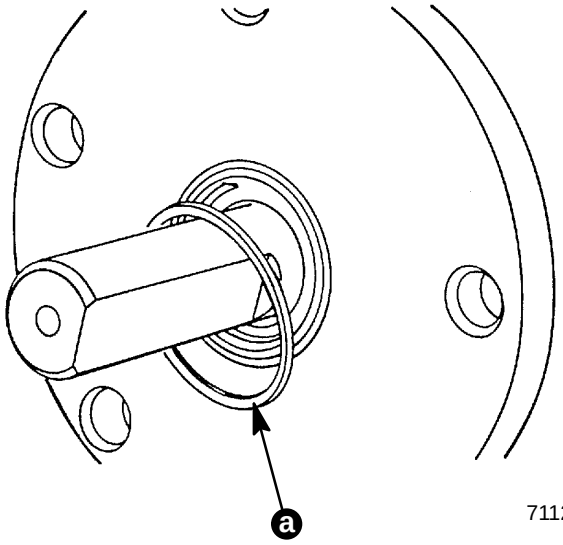
71148



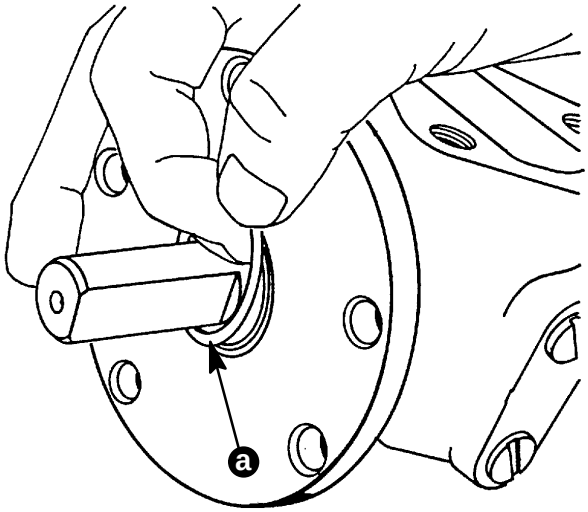
71130

a - OII Seal - Lip Toward Snap Ring

8. Install quad ring seal on water pump end of housing.



71129



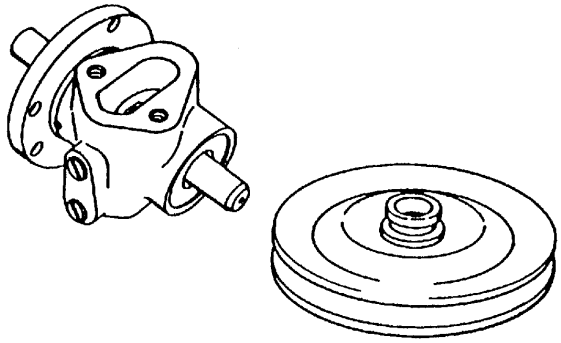
71128

a - Quad Ring Seal

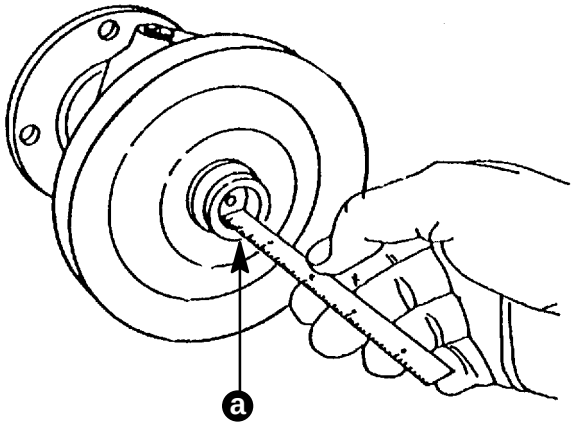
FUEL PUMP ASSEMBLY

IMPORTANT: Pulley must be pressed on exactly as described in the following step to avoid rapid belt wear.

1. Carefully press pulley onto shaft. Pulley is properly positioned when end of shaft is located 1/2 in. (13 mm) from front edge of pulley.



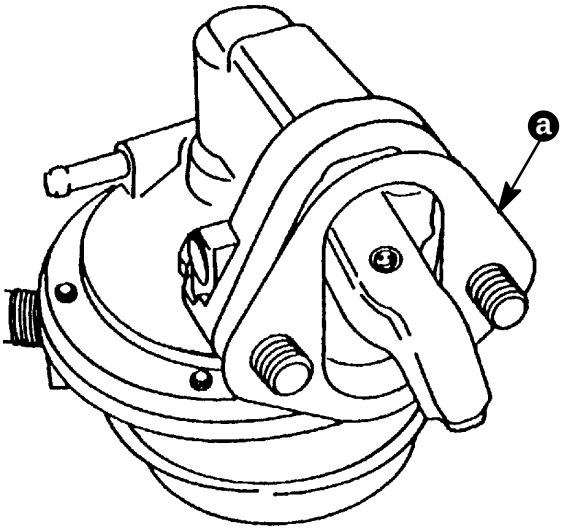
71127



71149

a - Pulley 1/2 In. (13 mm) Measurement

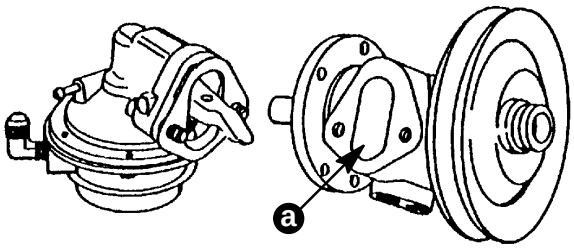
2. Apply a light coat of Quicksilver Perfect Seal to fuel pump gasket. Position gasket on fuel pump.



71124

a - Gasket

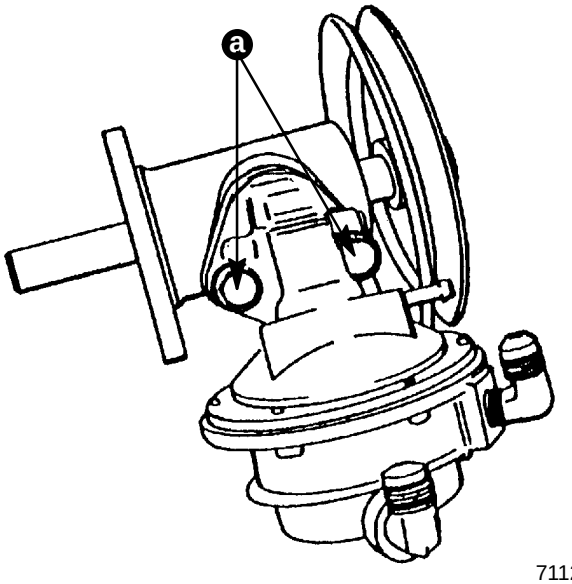
3. Turn on pulley to bring the low spot of fuel pump cam toward fuel pump lever.



71123

a - Fuel Pump Cam

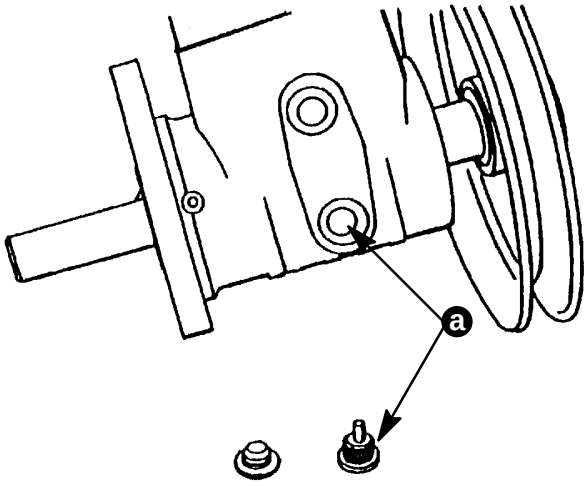
4. Install fuel pump on housing. Secure with bolts and lockwashers. Torque to 25-28 lb. ft. (34-38 N·m).



71122

a - Bolts and Lockwashers (2)

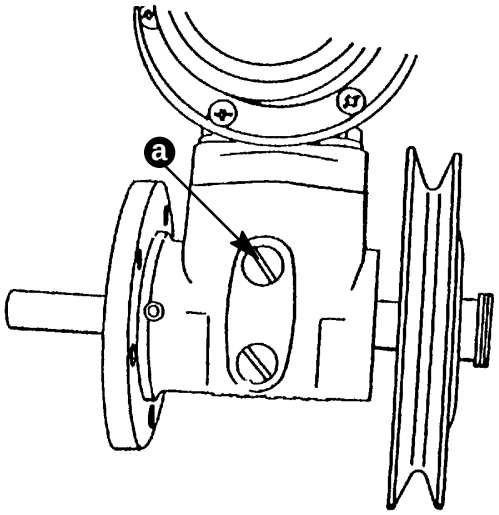
5. Install drain screw (with magnet) and sealing washer. Tighten securely [approximately 18 lb. in. (2 N·m)].



71121

a - Drain Screw (With Magnet)

6. Fill fuel pump housing with Quicksilver High Performance Gear Lube. Gear lube level should come up to bottom edge of top hole. Install fill screw with sealing washer and tighten securely [approximately 18 lb. in. (2 N·m)].

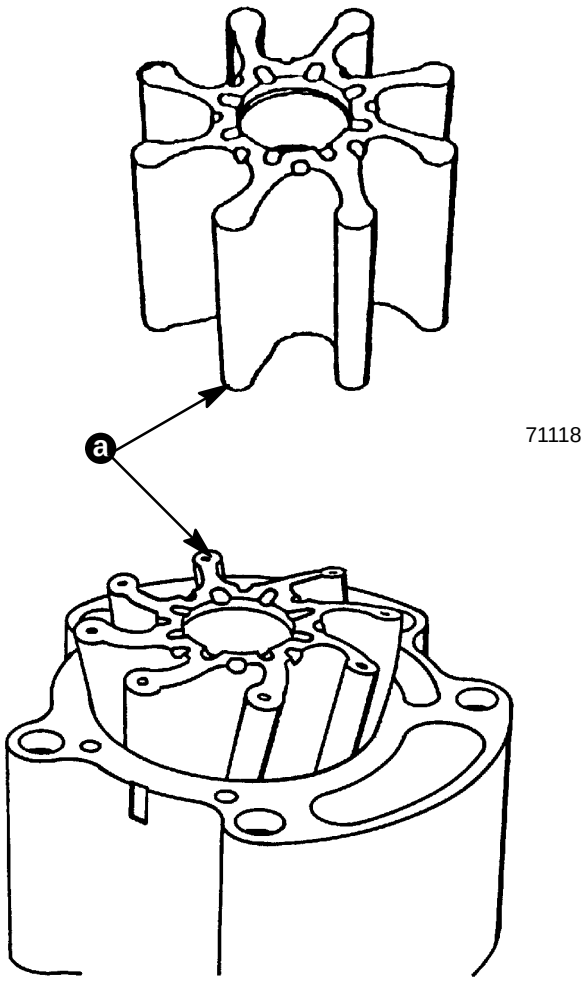


71120

a - Fill Screw

SEAWATER PUMP ASSEMBLY (ONE PIECE BODY)

1. Lubricate seawater pump impeller with a water and soap solution. Install impeller into housing by rotating and pushing it into place. Push it down until flush with housing.

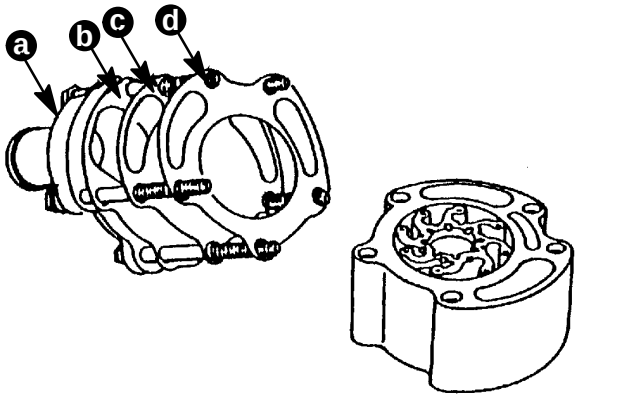


71118

71150

a - Impeller

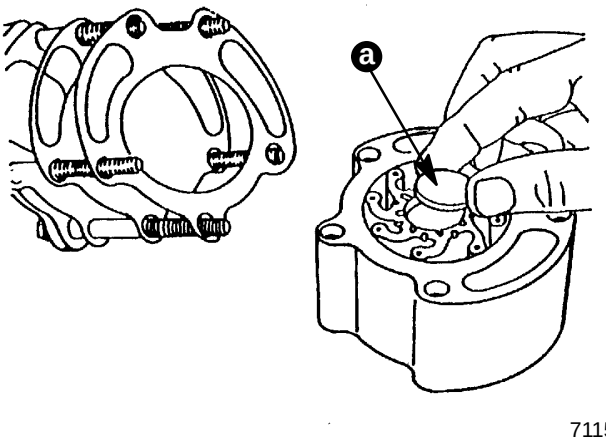
2. Install bolts with flat washers through water pump end cover. Position gaskets and wear plate as shown.



71151

a - End Cover
b - Gasket With Two Openings
c - Wear Plate
d - Gasket With Large Opening

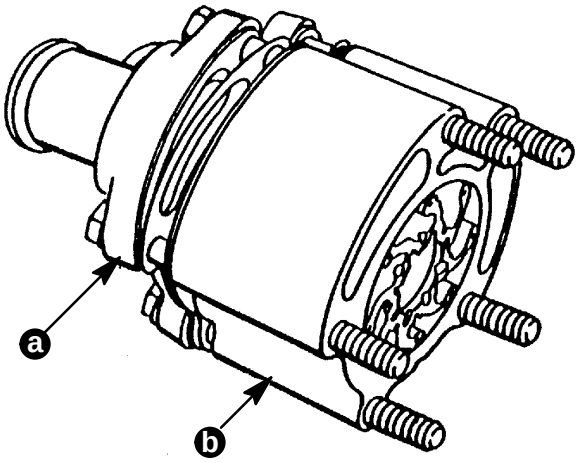
3. Place rubber plug in end of impeller that will be facing end cover.



71152

a - Rubber Plug

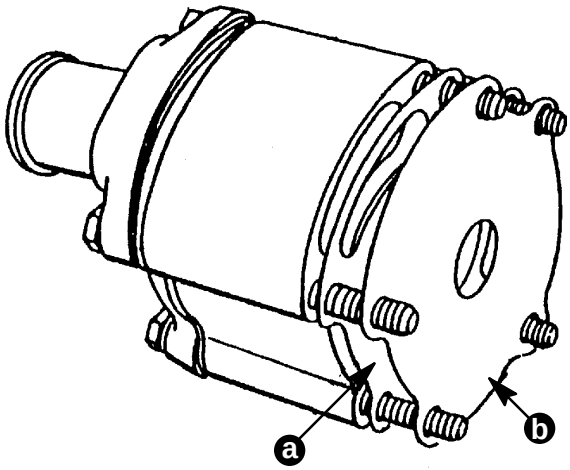
a. Slide water pump housing over bolts and join to end cover.



71153

a - End Cover
b - Water Pump Housing

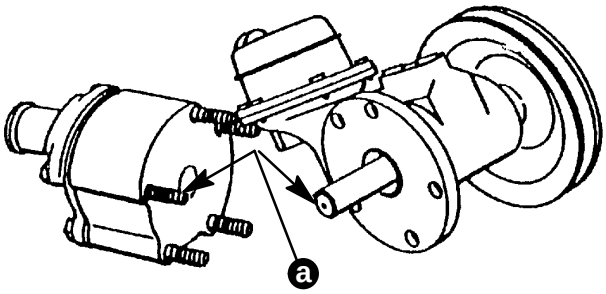
(1) Place gasket and wear plate over bolts and slide up against housing.



71154

a - Gasket (With Large Opening)
b - Wear Plate

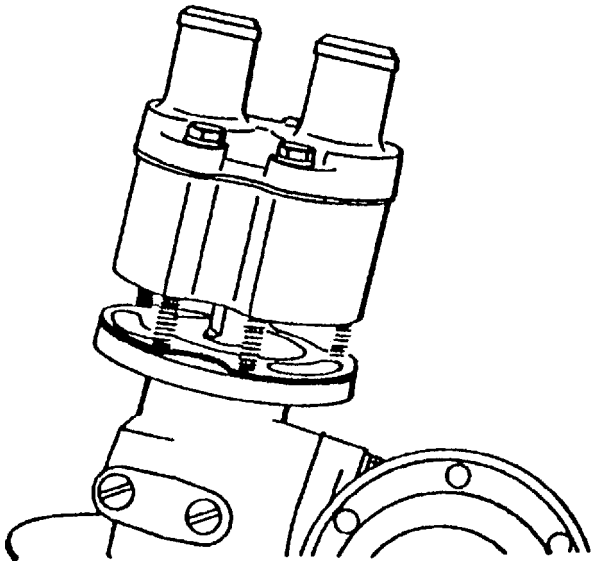
(2) Rotate shaft so that flat spot on shaft will be in the approximate position to line up with flat spot inside impeller.



71155

a - Flat Spot On Shaft

(3) While holding wear plate and gasket up against housing, carefully lower water pump assembly down onto shaft. Rotate assembly from side to side to align shaft and impeller.

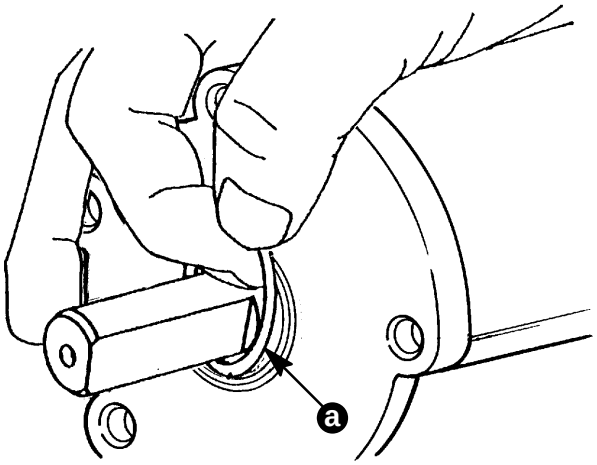


71156

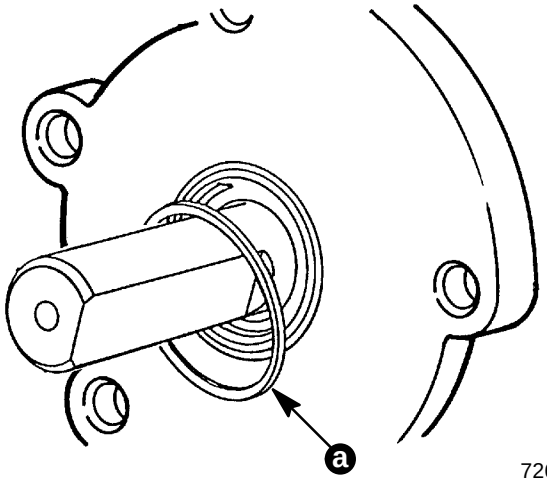
Seawater Pump Bearing Housing

Disassembly

1. Remove gasket, inner wear plate and quad ring seal. Discard gasket and quad ring seal.



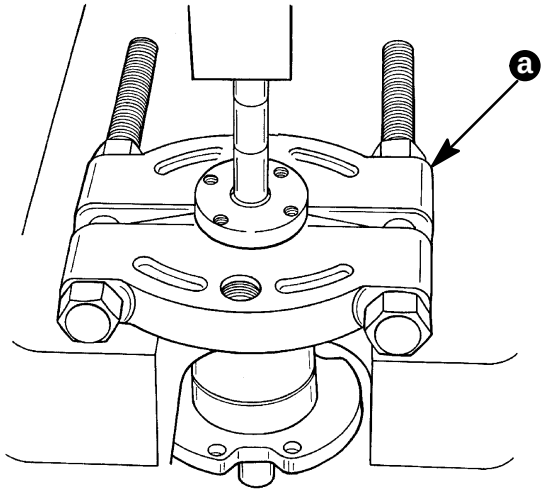
72655



72656

a - Quad Ring Seal

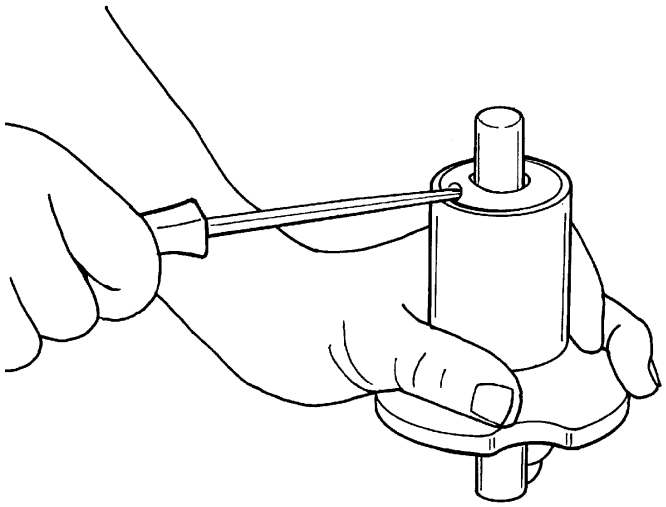
2. Press hub off shaft with Universal Puller Plate and an arbor press.



72648

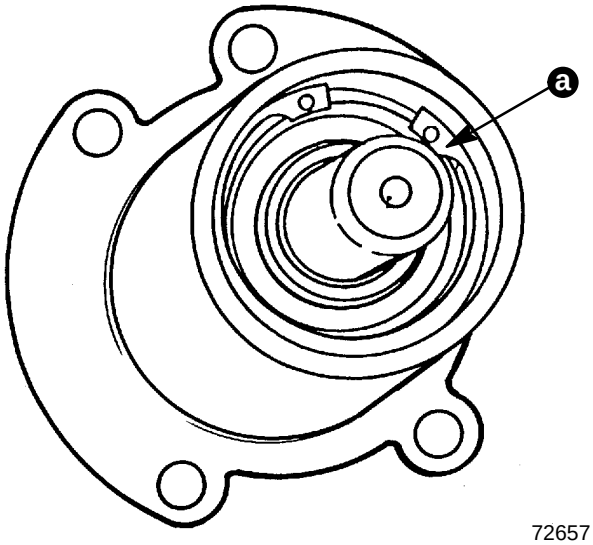
a - Universal Puller Plate (91-37241)

3. Puncture front oil seal with a tool and pry from bearing housing.

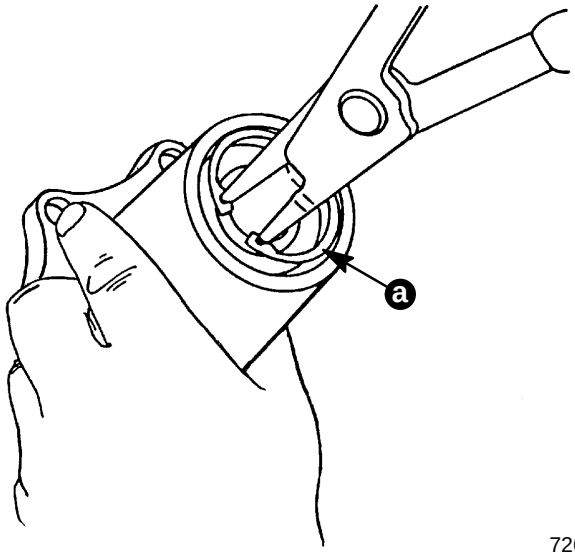


72649

4. Remove snap ring from bearing housing bore and press shaft and bearings out pulley end of housing. Bearings have a slip fit in housing; do not use excessive force.



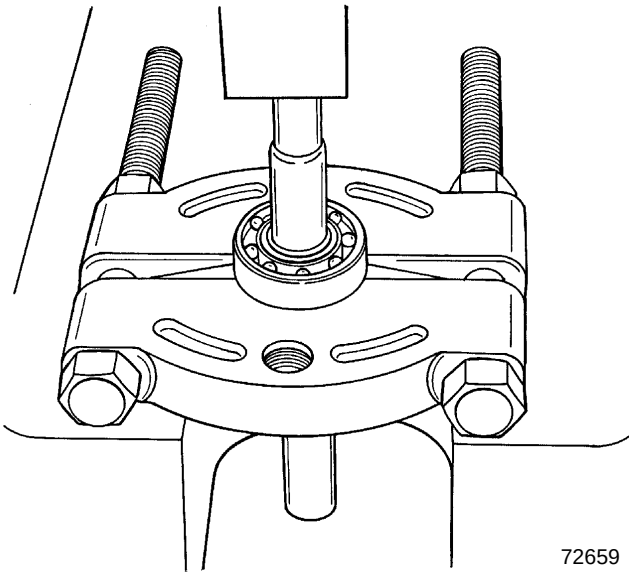
72657



72658

a - Snap Ring

5. If bearings require replacement, remove bearings from shaft with Universal Puller Plate and an arbor press. Bearings must be replaced, if removed.



72659

6. If rear seals require replacement, press seals from bearing housing with an appropriate tool.

Cleaning and Inspection

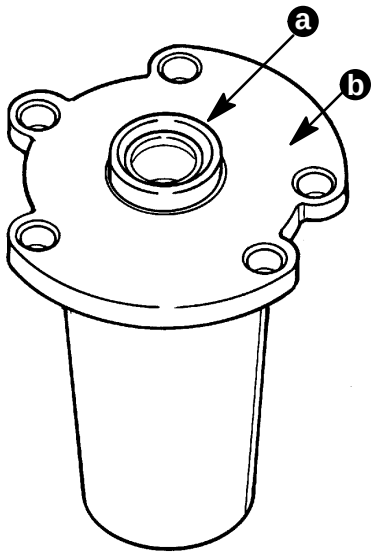
1. Clean metal parts in solvent and blow dry with compressed air.

IMPORTANT: Do not spin bearings at high speed when drying with compressed air, as bearings may be scored.

2. After cleaning, apply a coat of light engine oil to shaft and bearings to prevent rust.
3. Clean all gasket material and sealer from sealing surfaces.
4. Inspect bearing housing. Examine surfaces (where bearings contact housing) for evidence of bearing outer races turning in housing.
5. Inspect seals in bearing housing.
6. Inspect pump shaft bearings.
7. Inspect pump shaft for grooves in surface where seals contact shaft. Also inspect surface where bearings contact shaft for evidence of inner races turning on shaft.
8. Inspect pump body.
9. Inspect inner and outer wear plate.
10. Inspect pump impeller for wear on sides and tips of blades. Also inspect blades for cracks in area where blades flex. Replace impeller if blades have taken a set (remain in curved position).
11. Inspect pump pulley.
12. Check drive belt for excessive wear.

Reassembly

1. Apply a thin coat of Quicksilver Loctite Type 8831 to outside diameter of two new bearing housing rear seals; then install seals in housing with seal lips facing impeller end. (Press first seal in until it bottoms out and second seal in until flush with housing.)

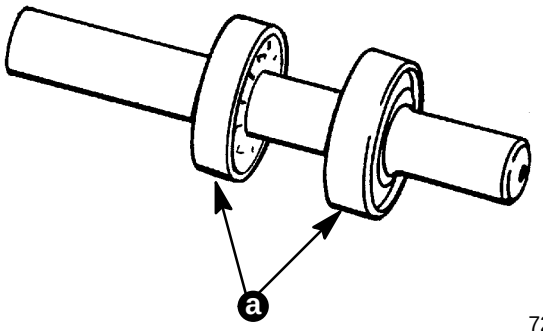


72660

a - Outer (Water) Seal
b - Face of Housing

IMPORTANT: It is recommended that Shell Alvania No. 2 Grease be used when packing seal and bearings in the following steps. If Shell Alvania No. 2 Grease is not available, it is permissible to use Quicksilver 2-4-C With Teflon. However, Quicksilver 2-4-C Marine Lubricant With Teflon is not recommended for applications where continuous high speed heavy-duty operation will be encountered.

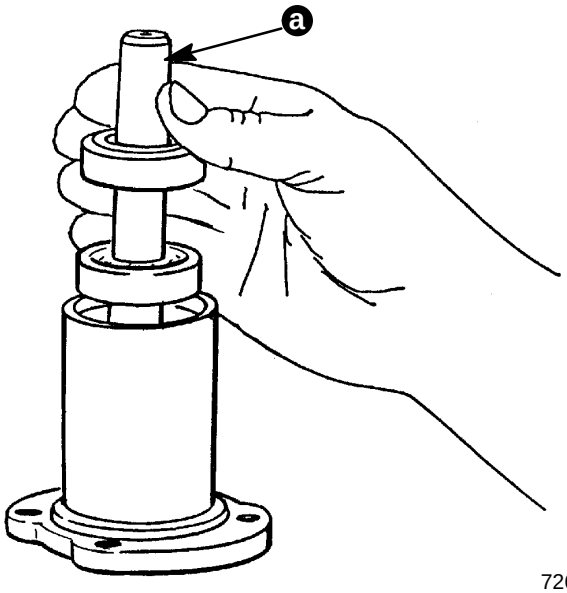
2. Pack cavity between seals with Shell Alvania No. 2 Grease or substitute.
3. Using an arbor press and suitable tool, press ball bearings onto shaft until they seat. Press on inner race of bearing only.



72663

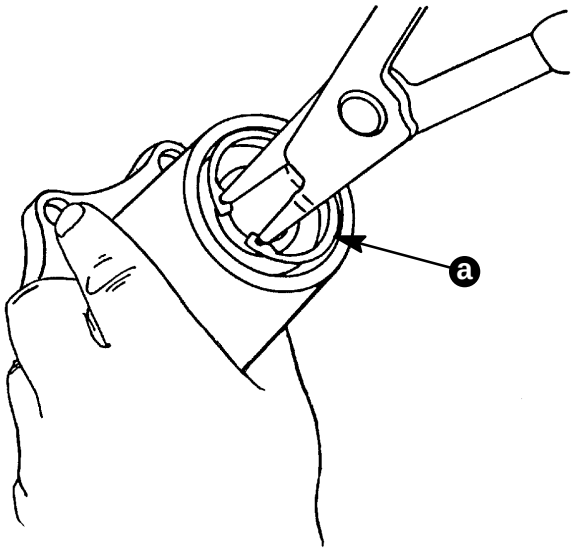
a - Bearings

4. Pack bearings and cavity between bearings with Shell Alvania No. 2 Grease or substitute. Slide bearings and shaft into bearing housing bore and install snap ring.



72661

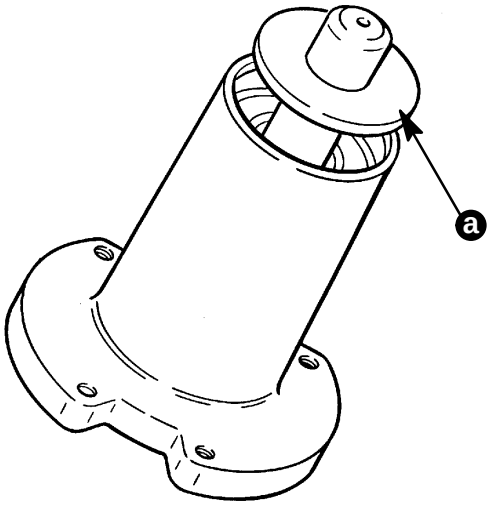
a - Shaft With Bearings



72658

a - Snap Ring

5. Apply a thin coat of Quicksilver Loctite 8831 to outside diameter of new bearing housing front oil seal and press seal into housing (with seal lip facing inward) until it bottoms out.

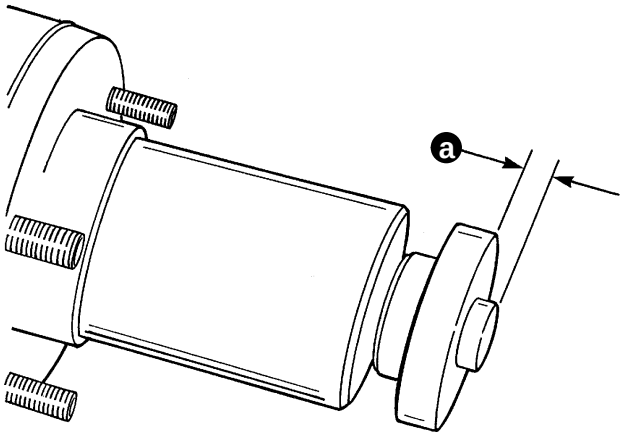


72662

a - Front Oil Seal

IMPORTANT: Be sure to support impeller end of pump shaft when installing pulley hub in next step to prevent placing a load on bearings.

6. Apply Quicksilver Special Lubricant 101 to pump shaft. Using an arbor press and appropriate tool, press pulley hub onto pump shaft to dimension shown.

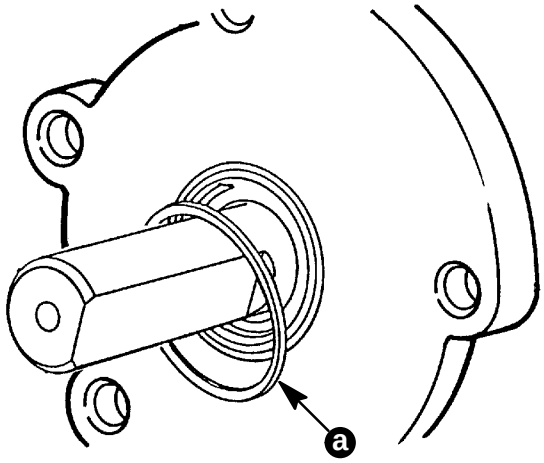


72664

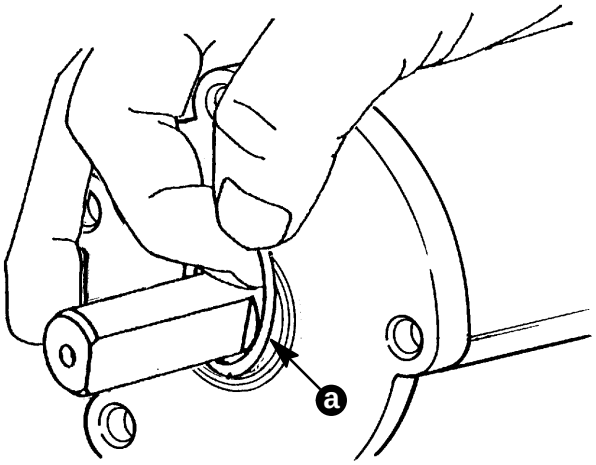
a - .260 Inch (6.6 mm)

IMPORTANT: Pulley hub must be pressed onto shaft to exact dimension on pumps with stamped steel mounting bracket as this establishes proper drive belt alignment.

7. Clamp bearing housing in a soft jaw vise with flange end up.
8. Coat quad ring seal with Quicksilver 2-4-C Marine Lubricant With Teflon and install into groove in housing.



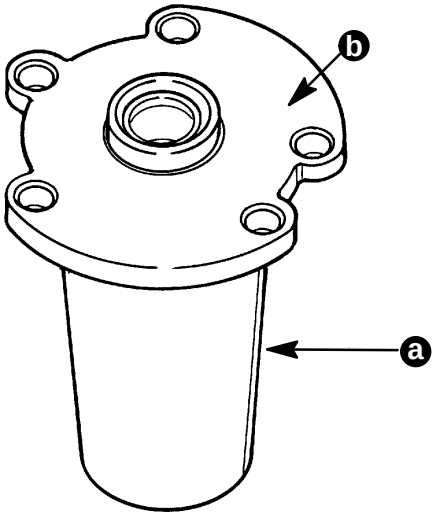
72656



72655

a - Quad Ring Seal

9. Place the wear plate over the bearing housing.

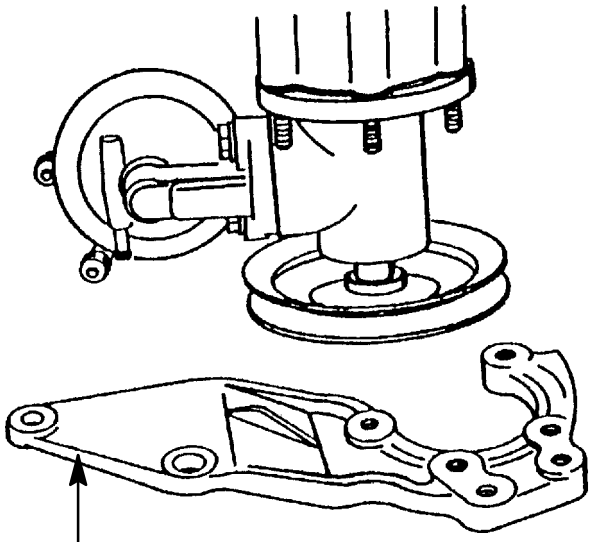


72660

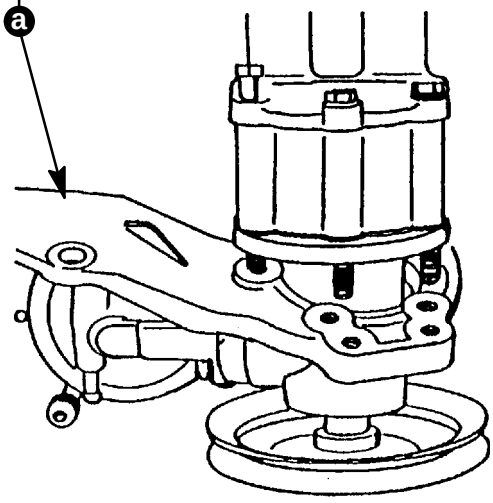
a - Bearing Housing
b - Wear Plate

PUMP BRACKET ATTACHMENT

1. Position main bracket as shown and install. Secure the water pump assembly to the bracket with four of the five bolts.



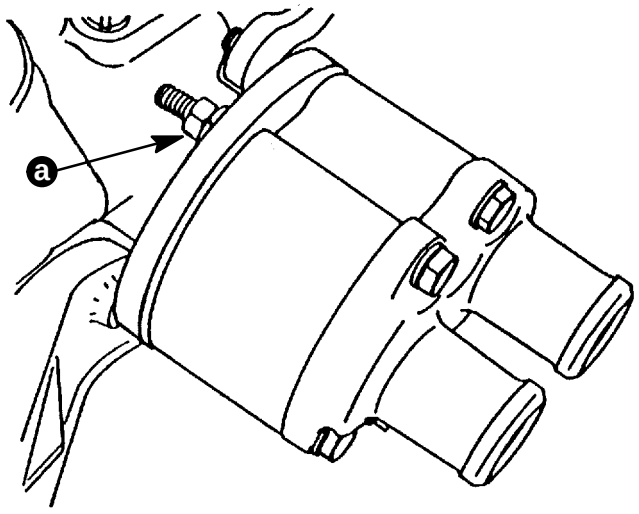
71111



71110

a - Bracket

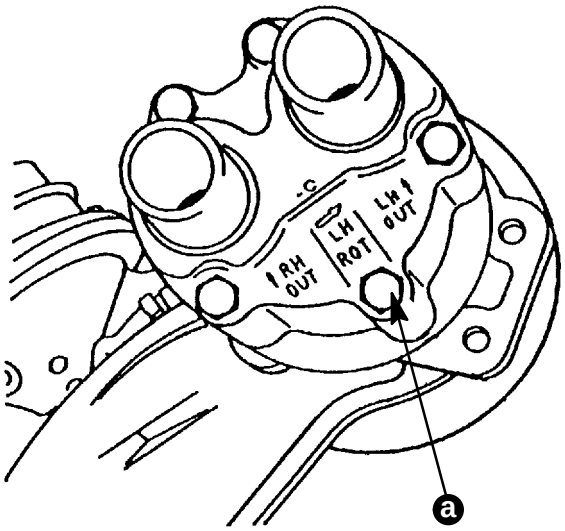
2. Secure the fifth bolt with a nut and lockwasher.



71109

a - Nut and Lockwasher

3. Torque all of these fasteners to 10-15 lb. ft. (14-20 N·m).

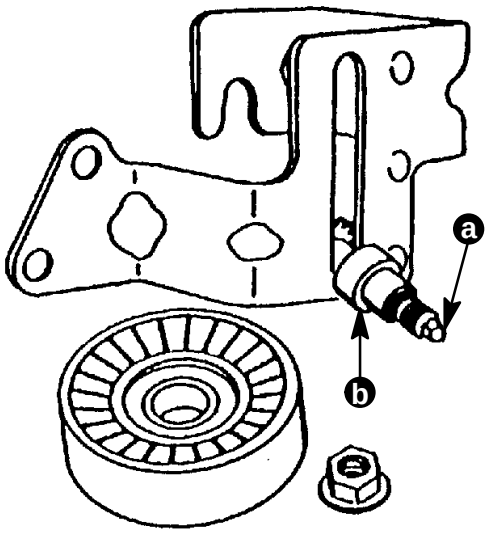


71108

a - Bolts

IDLER PULLEY ASSEMBLY

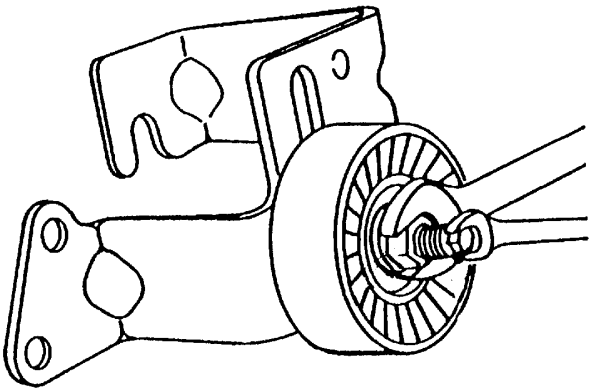
1. Install idler pulley adjusting bolt and bushing.



71106

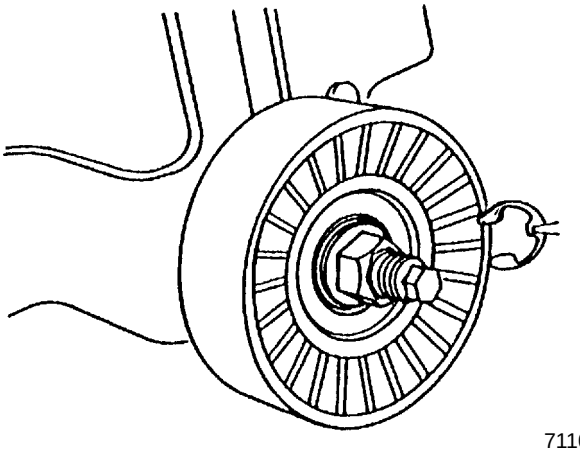
a - Adjusting Bolt
b - Bushing

2. Install idler pulley and secure with locknut. Tighten locknut while holding adjusting bolt. Do not tighten completely at this time as adjustment will be necessary when installing belt.

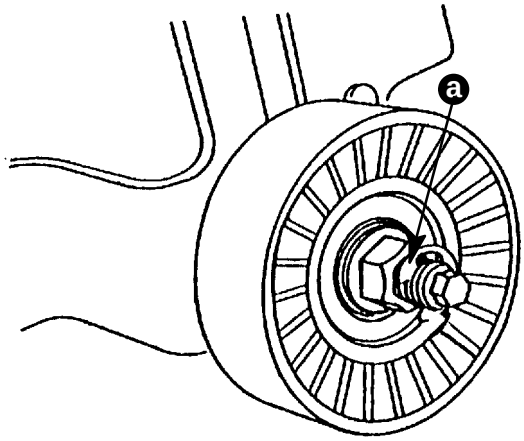


71105

3. Install retaining clip on adjusting bolt.



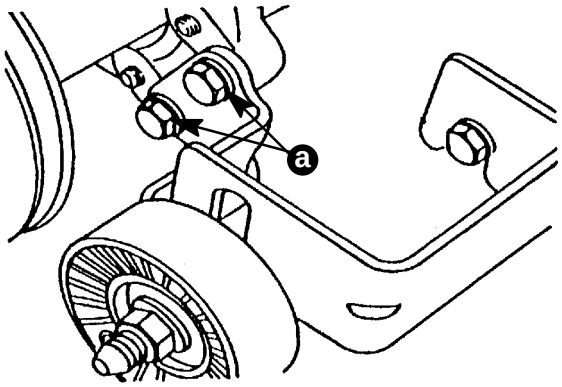
71104



71103

a - Retaining Clip

4. Install idler assembly bracket on pump housing. Secure with bolts and lockwashers. Torque to 30-35 lb. ft. (41-47 N·m).

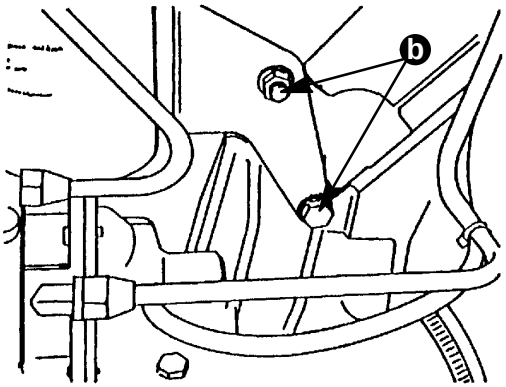


71102

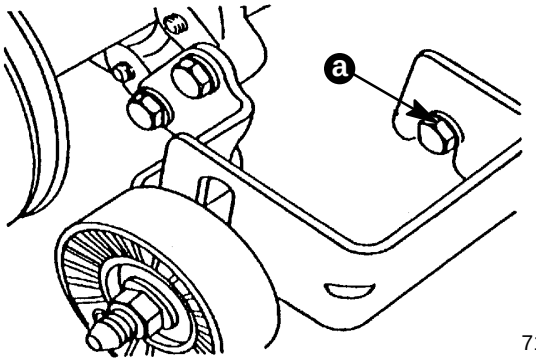
a - Bolts and Lockwashers (2)

Installation

1. Install seawater/fuel pump assembly. Secure with bolts and lockwashers as shown. Torque to 30 lb. ft. (41 N·m).



71161



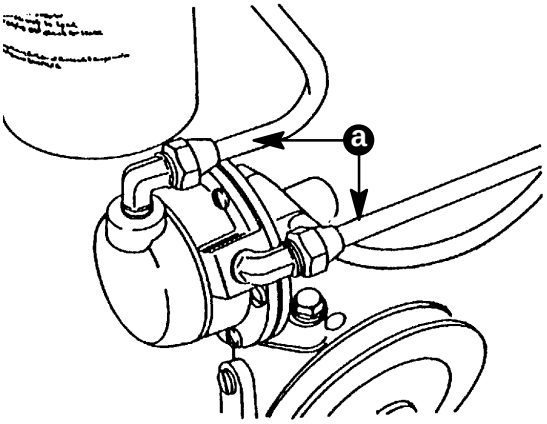
71102

a - Idler Bracket Bolt
b - Main Bracket Bolts (2)

⚠ WARNING

Be careful when working on fuel system components. Gasoline is extremely flammable under certain conditions. Be sure ignition key is OFF. Do not smoke or allow spark or open flame in area when working on fuel system components. Wipe up any spilled fuel immediately.

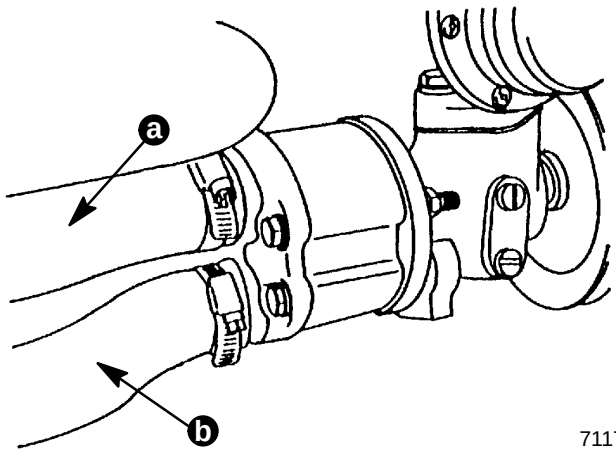
2. Connect fuel lines to fuel pump and tighten securely.



71169

a - Fuel Lines

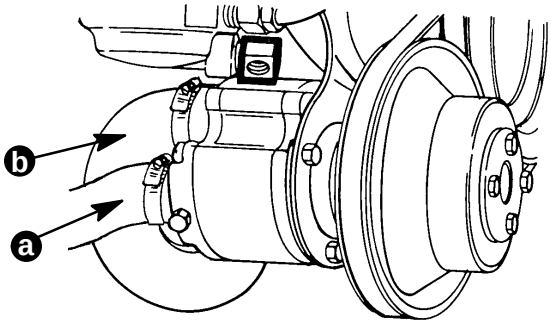
3. Connect water hoses to seawater pump.



71170

Engines With Combination Seawater / Mechanical Fuel Pump

a - Seawater Inlet Hose
b - Hose To Cooler

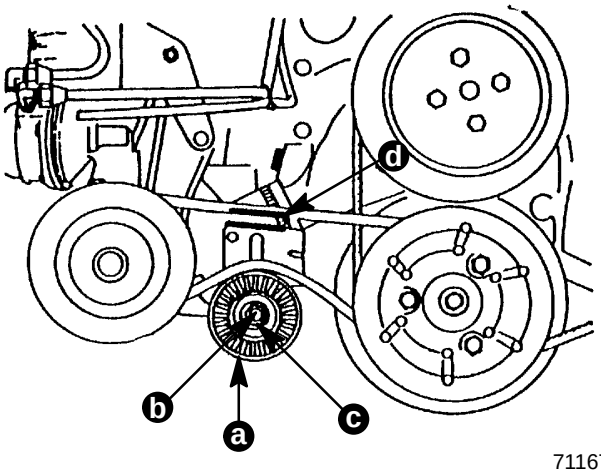


72352

Engines WIth Cool Fuel System

a - Seawater Inlet Hose
b - Hose To Cooler

4. Install drive belt. Adjust belt tension using the adjusting bolt and locknut. When adjustment is correct, torque locknut to 30 lb. ft. (41 N·m). Tension is checked by pushing on belt in area opposite the idler pulley. Belt should depress approximately 1/4 in. (6 mm).



71167

a - Idler Pulley
b - Adjusting Bolt
c - Locknut
d - Belt Deflection Measurement

Water Circulating Pump Replacement

Removal

1. Drain water from cylinder block.
2. Break loose circulating pump pulley attaching bolts. Do not remove bolts at this time.

3. **Power Steering Models:** Loosen power steering pump brace and pump mounting bolts, then pivot pump inward and remove drive belts (some models).
4. Loosen alternator brace attaching bolts and alternator mounting bolt, then pivot alternator inward and remove drive belt.
5. Remove pump pulley attaching bolts, lockwashers, clamping ring (if so equipped) and pulley.
6. Disconnect hose(s) from pump.
7. Remove bolts, which secure pump to cylinder block, and remove pump and old gaskets (discard gaskets).

Cleaning and Inspection

1. Clean gasket surfaces on water pump and cylinder block.
2. Inspect water pump for blockage, cracks, sand holes, corrosion or other damage. Inspect pump impeller for cracks and erosion. Replace complete pump if any damage exists.
3. Check impeller shaft and bearings for excessive side play. If play can be felt, replace complete pump.
4. Inspect pump pulley for bends, cracks, corrosion or other physical damage. Inspect pulley for rotational trueness. Replace pulley if damaged or untrue.

Installation

1. Coat both sides of new circulating pump gasket with Quicksilver Perfect Seal, then position gaskets and circulating pump on cylinder block. Coat threads of circulating pump attaching bolts with Quicksilver Perfect Seal and install bolts and alternator brace (if applicable). Torque bolts to specifications.
2. Reconnect hoses to pump.
3. Install pump pulley and clamping ring (if used) on pump hub and secure with bolts and lockwashers. Tighten bolts securely.
4. Install drive belts and adjust tension as outlined in “Drive Belt Tension Adjustment.”
5. Start engine and check for leaks.

Drive Belt Tension Adjustment

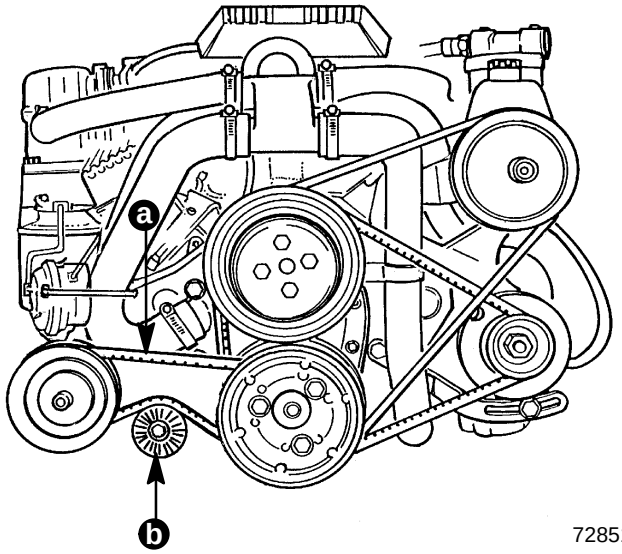
Belt Driven Combination Seawater/ Fuel Pump

IDLER PULLEY

1. Belt should depress 1/4 in. (6 mm) at location shown.
2. To adjust belt tension, adjust idler pulley.

⚠CAUTION

DO NOT over-adjust idler pulley. Too much tension on belt will cause bearings in seawater pump to fail.



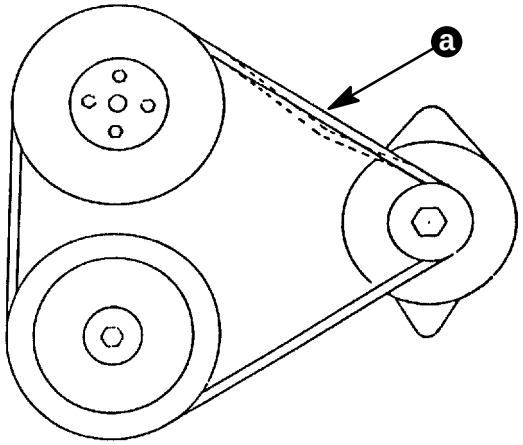
72851

a - Power Steering Belt
b - Idler Pulley

3. If a new drive belt has been installed, recheck belt tension after running for five minutes.

Alternator

1. Install drive belt on pulleys and adjust tension as follows:
   a. Pivot alternator away from engine, as required, until correct tension is obtained as shown. Belt should depress 1/2 in. (13 mm).



72669

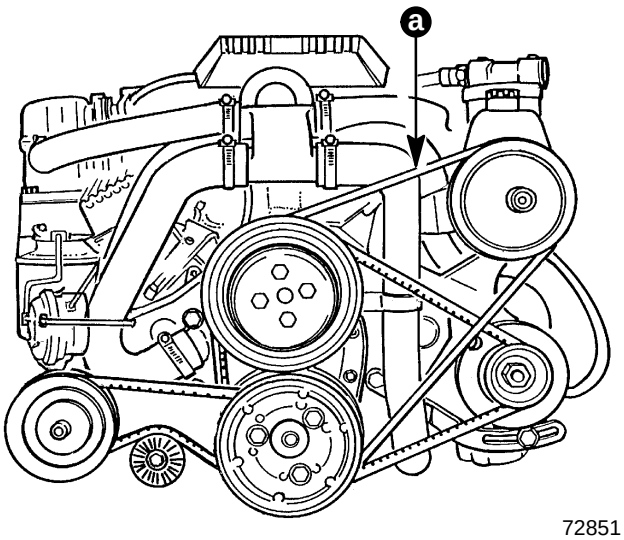
a - Depress Here

   b. After obtaining correct tension, securely retighten alternator brace attaching bolts and alternator mounting bolt.
2. If a new drive belt has been installed, recheck belt tension after running for five minutes.

Power Steering Pump

IMPORTANT: Do not pry on pump with pry bar or screwdriver.

1. Install drive belt on pulleys and adjust tension as shown.
   a. Pivot pump away from engine, as required, until correct tension is obtained.
   b. After obtaining correct tension, securely retighten pump brace and pump mounting bolts.
2. If a new drive belt has been installed, recheck belt tension after running for five minutes. Belt should depress 1/4 in. (6 mm).



72851

a - Depress Here

Flushing Seawater Cooling System

If engine is operated in salty, polluted or mineral-laden waters, seawater cooling system should be flushed periodically (preferably after each use) with fresh water to reduce corrosion and prevent the accumulation of deposits in the system. Seawater cooling system also should be thoroughly flushed prior to storage.

⚠ WARNING

When flushing, be certain the area around propeller is clear, and no one is standing nearby. To avoid possible injury, remove propeller.

⚠ CAUTION

Do not run engine above 1500 RPM when flushing. Suction created by seawater pickup pump may collapse flushing hose, causing engine to overheat.

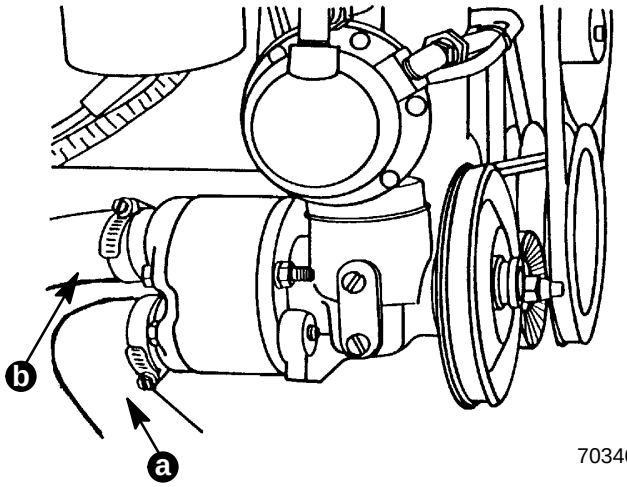
IMPORTANT: If cooling system is to be flushed with boat in the water, seacock (if so equipped) must be closed, or water inlet hose must be disconnected and plugged to prevent water from flowing into boat.

⚠ CAUTION

Watch temperature gauge at dash to ensure the engine does not overheat.

Belt Driven Seawater Pump

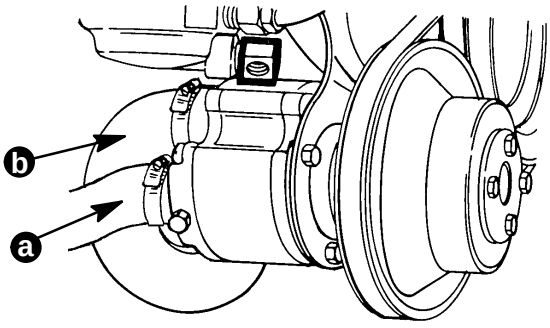
1. Close seacock (if so equipped) or remove and plug seawater inlet hose.
2. Loosen hose clamp and remove seawater inlet hose at location shown. Connect tap water hose to inlet fitting.



70346

With Combination Seawater / Mechanical Fuel Pump

a - Hose To Cooler
b - Seawater Inlet Hose



72352

Without Mechanical Fuel Pump

a - Seawater Inlet Hose
b - Hose To Cooler

3. Partially open water tap (approx. 1/2 maximum capacity) and allow cooling system to fill completely. Cooling system is full when water is discharged through the exhaust. Do not use full tap water pressure.
4. Place the remote control lever in NEUTRAL position and start the engine. Operate engine at idle speed in NEUTRAL gear for 10 minutes or until discharge water is clear, then stop engine.

⚠ CAUTION

If boat is in the water, seacock (if so equipped) must be left closed until engine is to be restarted, to prevent water from flowing back into cooling system. If boat is not fitted with a seacock, water inlet hose must be left disconnected and plugged, to prevent water from flowing into cooling system and/or boat. As a precautionary measure, attach a tag to the ignition switch or steering wheel with the warning that the seacock must be opened or the water inlet hose reconnected prior to starting the engine.

5. Shut off tap water. Remove flushing connector from pump inlet. Refer to preceding precautionary statement and then follow instructions “a” or “b.”
   a. **If equipped with seacock:** Reconnect water inlet hose and tighten hose clamp securely. Open seacock accordingly.
   b. **If NOT equipped with seacock:** Unplug and reconnect seawater inlet hose accordingly. Tighten hose clamp securely.

Check/Clean Seawater Strainer

NOTICE

Refer to manufacturer’s instructions for information on checking and cleaning of other than Quicksilver Seawater Strainer.

1. Visually inspect seawater strainer through glass top.

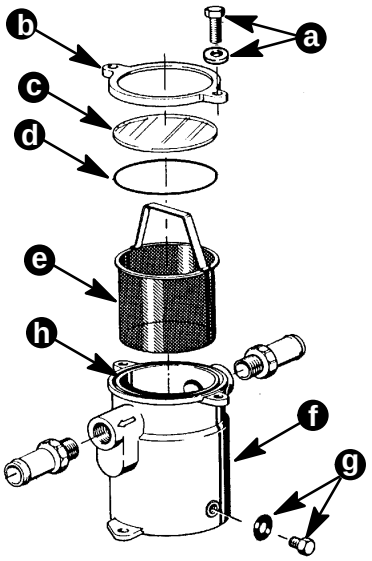
⚠ WARNING

When cleaning seawater strainer, close seacock, if so equipped. If boat is not equipped with a seacock, remove and plug seawater inlet hose to prevent a siphoning action that may occur, allowing seawater to flow from the drain holes or removed hoses.

⚠ CAUTION

Do not over-tighten cover screws or cover will warp and leak.

2. With engine off, close seacock, if so equipped, or remove and plug seawater inlet hose, if no seacock exists. Remove two screws and washers, and cover. Remove strainer, and drain plug and washer. Clean any debris from strainer housing; flush both strainer and housing with clean water. Check gasket; replace when necessary (if it leaks). Reinstall strainer, drain plug and washer. Reattach cover with screws and washers. Open seacock, or unplug and reconnect seawater inlet hose. Tighten hose clamps securely. After starting engine, check for leaks and/or air in system, which would indicate an external leak.



72673

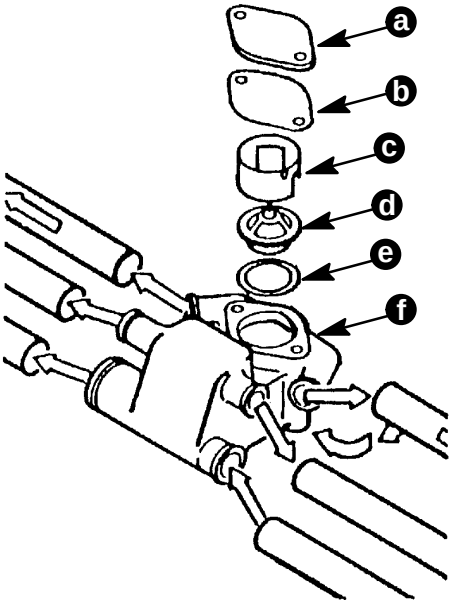
Quicksilver Seawater Strainer Shown

a - Screws and Washers
b - Cover
c - Glass
d - O-Ring
e - Strainer
f - Housing
g - Drain Plug and Sealing Washer
h - Gasket

Thermostat

Removal

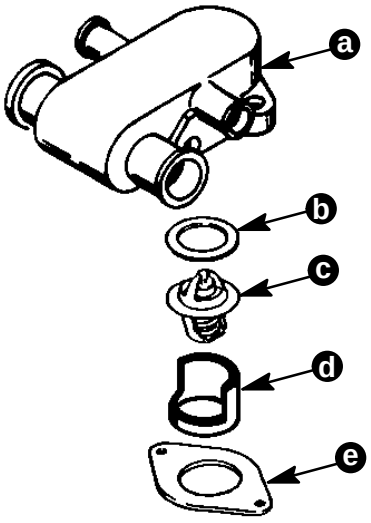
1. Drain water from cylinder block and exhaust manifolds.
2. On all models except stainless steel thermostat housing, remove thermostat cover attaching bolts and lockwashers, then remove cover and gasket. On stainless steel thermostat housing, remove thermostat housing.
3. Remove thermostat from thermostat housing or cover.



72589

All Engines Except Stainless Steel Thermostat Housings.

a - Cover
b - Gasket
c - Spacer
d - Thermostat (Typical)
e - O-Ring
f - Housing



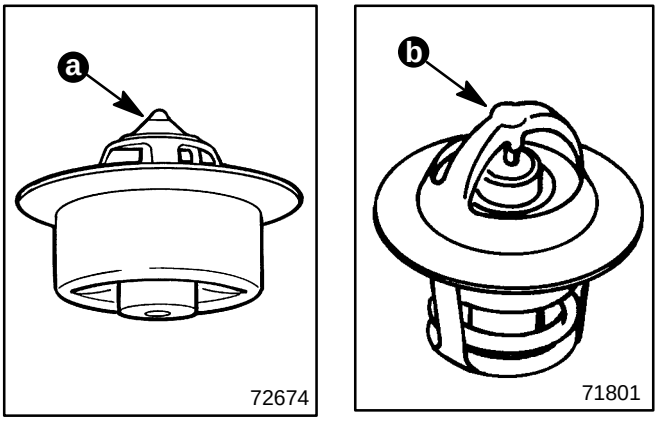
71758

Stainless Steel Thermostat Housing

a - Housing
b - O-Ring
c - Thermostat (Stainless Steel)
d - Spacer
e - Gasket

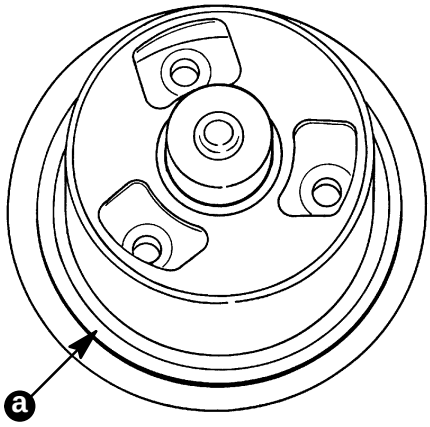
Testing

1. Clean thermostat in soap and water to remove any deposits or debris.
2. Inspect thermostat for corrosion or other visible damage.



a - Brass Thermostat
b - Stainless Steel Thermostat

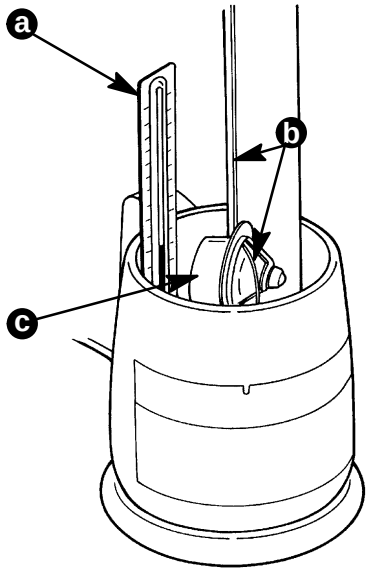
3. If thermostat is suspected of producing insufficient engine temperature, check thermostat for leakage by holding it up to a lighted background. Light leakage around the thermostat valve indicates that thermostat is not closing completely and should be replaced. (A small amount of leakage at one or two points around the valve perimeter is acceptable.)



Brass Thermostat Shown (Stainless Similar)

a - Check For Light Leakage Around Perimeter Of Valve

4. Check opening and closing temperature of thermostat (using a tester similar to the one shown) as follows:
   a. Fill tester to within 1 in. (25mm) of top with tap water. Do not use distilled water.
   b. Open thermostat valve and insert nylon string. Position thermostat on string so that it will be just below water level when suspended, then allow valve to close. Suspend thermostat in water.
   c. Place thermometer in container and position so that bottom of thermometer is even with bottom of thermostat. Do not allow thermometer to touch container.



a - Thermometer
b - Nylon String
c - Thermostat

IMPORTANT: When performing procedures "d"-"f," water must be agitated thoroughly to obtain accurate results.

   d. Plug in tester and observe temperature at which thermostat opens (thermostat drops off thread). Thermostat must open at specified temperature stamped on thermostat.
   e. Continue to heat water until a temperature 25°F (14°C) above temperature specified on thermostat is obtained. Thermostat valve must be completely open at this temperature.
   f. Unplug tester and allow water to cool to a temperature 10°F (5°C) below specified temperature on thermostat. Thermostat must be completely closed at this temperature.
   g. Replace a thermostat that fails to meet all of the preceding tests.

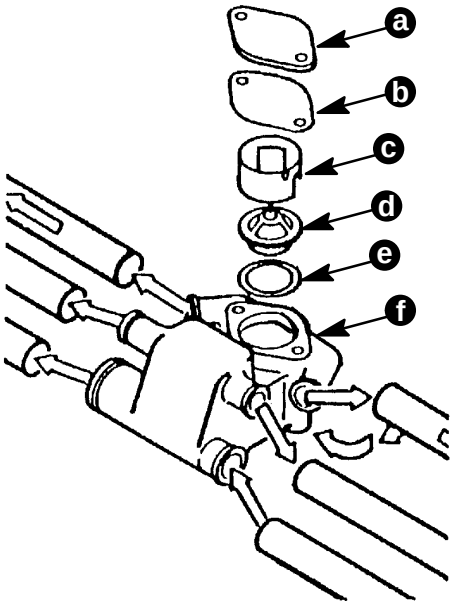
Installation

ALL MODELS EXCEPT STAINLESS STEEL THERMOSTAT HOUSING

1. Clean gasket surfaces on thermostat cover and thermostat housing.
2. If thermostat housing was disturbed during removal of thermostat, remove thermostat housing. Clean gasket surfaces on thermostat housing and intake manifold and replace thermostat housing-to-intake manifold gasket.

IMPORTANT: Gasket has continuity rivets. Do not coat with Quicksilver Perfect Seal, or audio warning temperature switch may not work properly.

3. Place O-ring in the thermostat housing. Be certain it is positioned properly on mounting flange in housing.
4. Place thermostat in thermostat housing with thermostatic element end toward housing bottom, as shown.
5. Align tang on sleeve with groove in thermostat housing bore and install sleeve into housing.
6. Coat both sides of new thermostat cover-to-thermostat housing gasket with Quicksilver Perfect Seal and position on housing.
7. Reinstall thermostat cover (with engine lifting eye, if so equipped) and torque screws with lockwashers to 30 lb. ft. (41 N·m).
8. Reconnect hose(s) to thermostat housing. Tighten hose clamps securely.
9. Start engine and inspect for leaks.



72589

a - Cover
b - Gasket
c - Spacer
d - Thermostat (Typical)
e - O-Ring
f - Housing

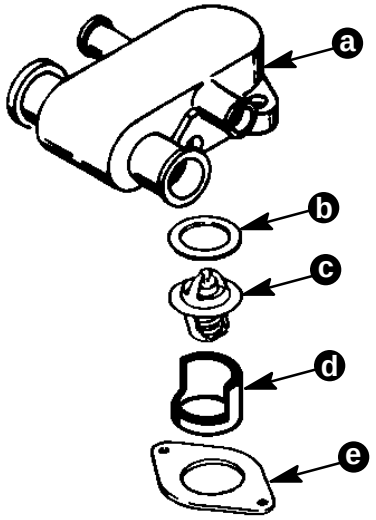
MODELS WITH STAINLESS STEEL THERMOSTAT HOUSING

1. Clean gasket surfaces on thermostat housing and intake manifold.

IMPORTANT: Gasket has continuity rivets. Do not coat with Quicksilver Perfect Seal, or audio warning temperature switch may not work properly.

2. Place O-ring in the thermostat housing. Be certain it is positioned properly in housing.
3. Place thermostat in thermostat housing with thermostatic element end toward housing bottom, as shown.
4. Align tang on sleeve with groove in thermostat housing bore and install sleeve into housing.
5. Coat both sides of new thermostat housing gasket with Quicksilver Perfect Seal and position on intake manifold.
6. Reinstall thermostat housing and torque screws with lockwashers to 30 lb. ft. (41 N·m).
7. Reconnect hose(s) to thermostat housing. Tighten hose clamps securely.

8. Start engine and inspect for leaks.



71758

a - Housing
b - O-Ring
c - Thermostat (Stainless Steel)
d - Spacer
e - Gasket

Draining Seawater Cooling System

Draining Precautions

⚠ CAUTION

If boat is in the water, seacock, if so equipped, must remain closed until engine is to be restarted to prevent water from flowing back into cooling system and/or boat. If boat is not fitted with a seacock, water inlet hose must be disconnected and plugged to prevent water from flowing back into cooling system and/or boat. As a precautionary measure, attach a tag to the ignition switch or steering wheel of the boat with the warning that the seacock must be opened or the water inlet hose reconnected prior to starting the engine.

NOTICE

For cold weather or extended storage information and procedures, refer to SECTION 1B.

IMPORTANT: Observe the following information to ensure complete draining of cooling system.

- **Engine must be as level as possible.**
- **A wire should be repeatedly inserted into all drain holes to ensure there are no obstructions in passages.**

IMPORTANT: To prevent threads in manifolds, elbows and cylinder blocks from rusting out during storage, reinstall plugs using Quicksilver Perfect Seal on threads. Never leave drain plugs out during storage.

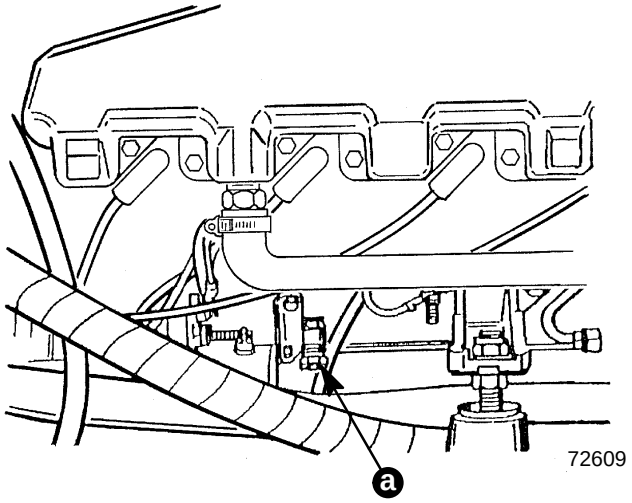
NOTE: *If possible, place a container under drains and hoses to prevent water from draining into boat.*

MCM (Stern Drive) Models

NOTICE

Refer to "Draining Precautions," in this section, BEFORE proceeding.

1. Ensure engine is as level as possible to ensure complete draining of cooling system.
2. Remove drain plugs (port and starboard) from cylinder block.



72609

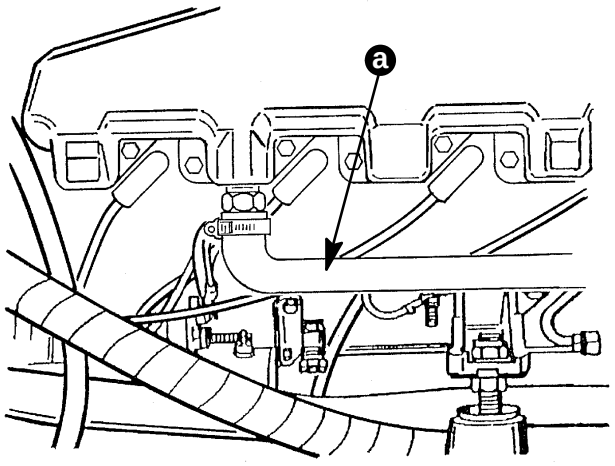
Starboard Side Shown (Port Similar)

a - Drain Plug

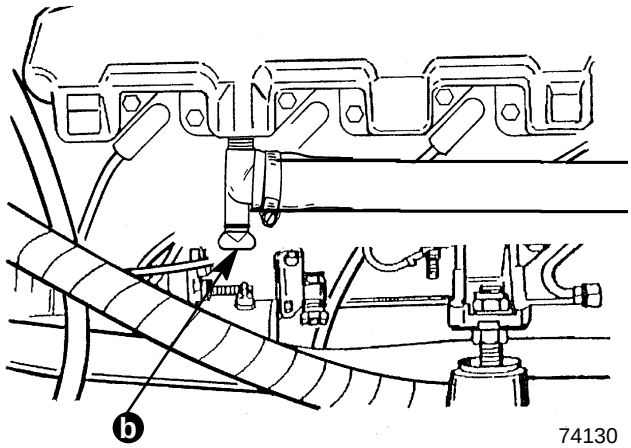
3. Repeatedly clean out drain holes using a stiff piece of wire. Do this until entire system is drained.

NOTE: *It may be necessary to lift, bend, or lower hoses to allow water to drain completely when hoses or drain plugs are disconnected.*

4. Remove hose or drain plug from bottom of port and starboard manifolds.



72609

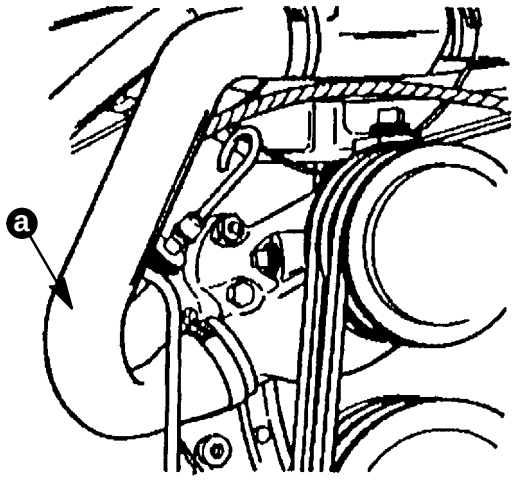


74130

Starboard Side Shown (Port Similar)

a - Bottom Hose, Exhaust Manifold To Thermostat Housing
b - Drain Plug In Elbow (Later Models)

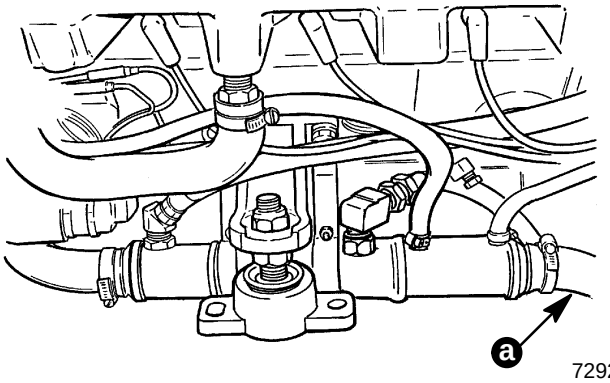
5. Remove the engine water circulating pump hose as shown.



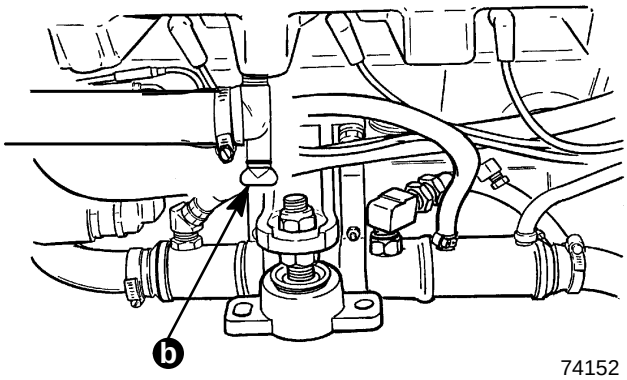
72587

a - Hose, Water Circulating Pump To Thermostat Housing

6. **On 7.4L and 454 Magnum Engines:** Remove the oil/power steering fluid cooler seawater hose or drain plug, as shown.



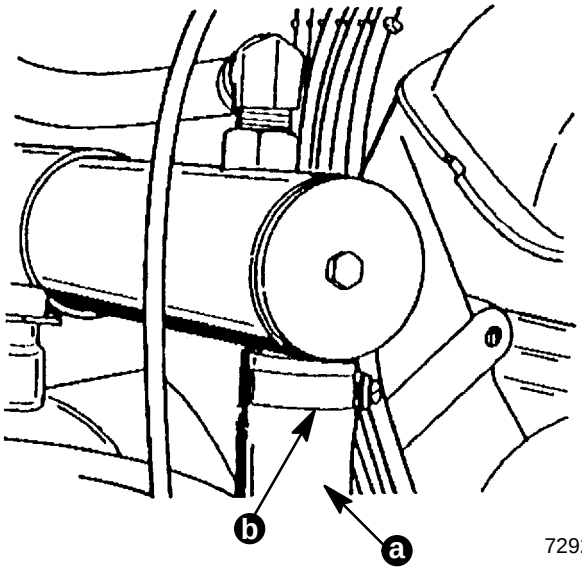
72925



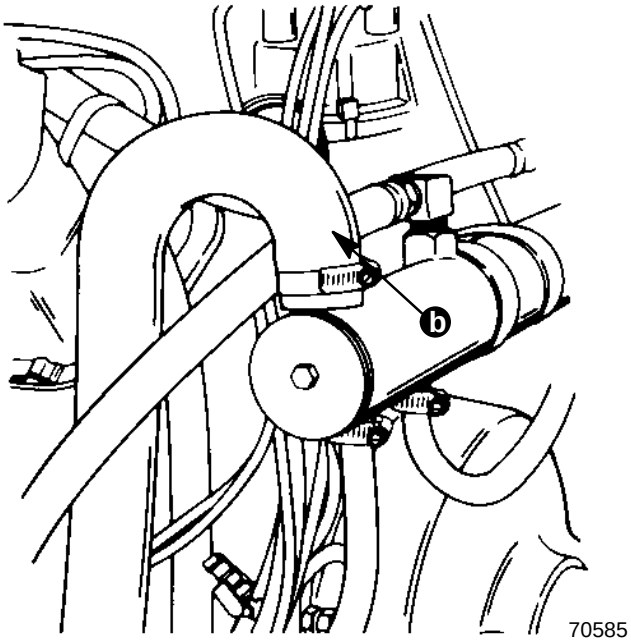
74152

a - Hose, Seawater Pump To Cooler
b - Drain Plug In Elbow (Later Models)

7. **502 Magnum Engines:** Remove the oil/power steering fluid cooler seawater hoses, as shown.

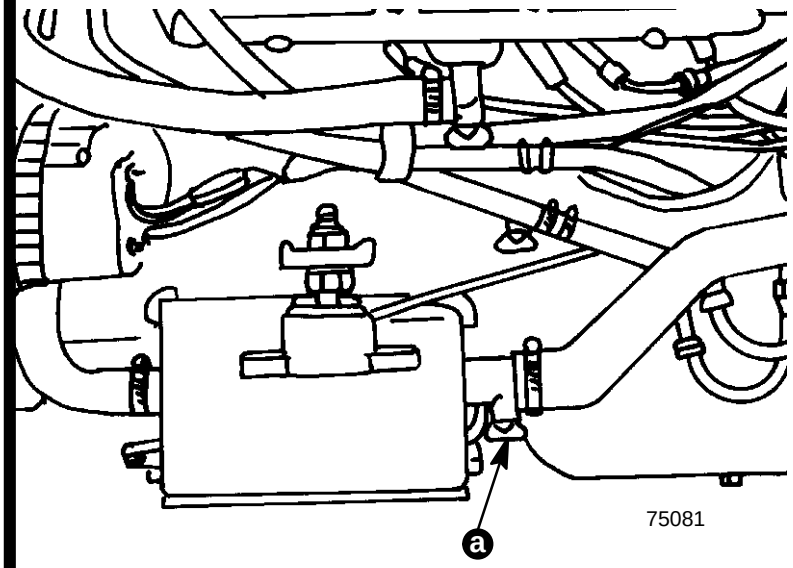


a - Hose, Seawater Pump To Cooler



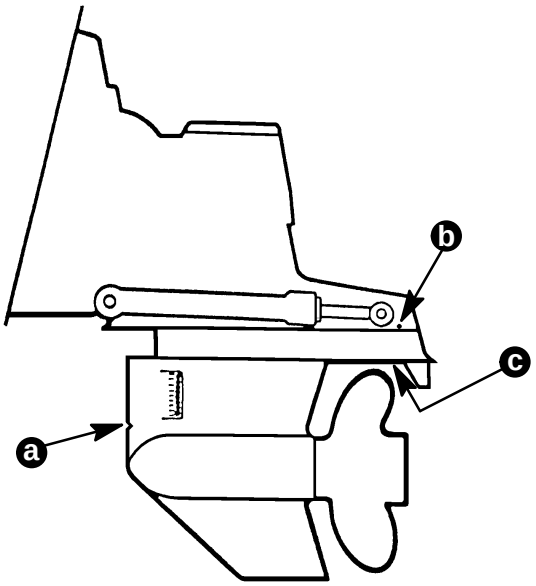
a - Hose, Oil / Power Steering Cooler To Heat Exchanger

8. **Engines with Cool Fuel System:** Remove drain plug from aft end of fuel cooler.



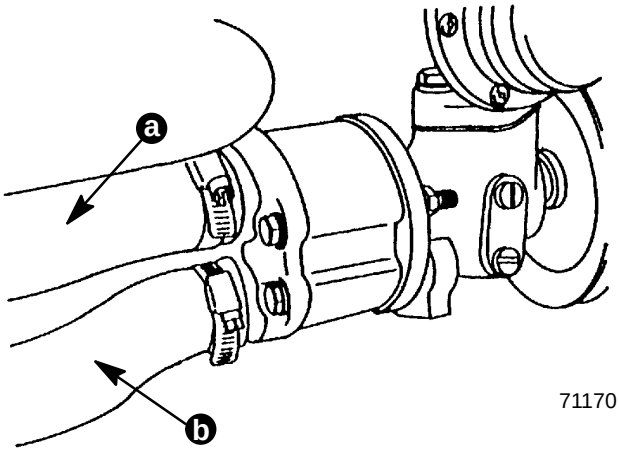
a - Drain Plug

9. Insert a small wire (repeatedly) to make sure that speedometer pitot tube, trim tab cavity vent hole, and trim tab cavity drain passage are unobstructed and open.



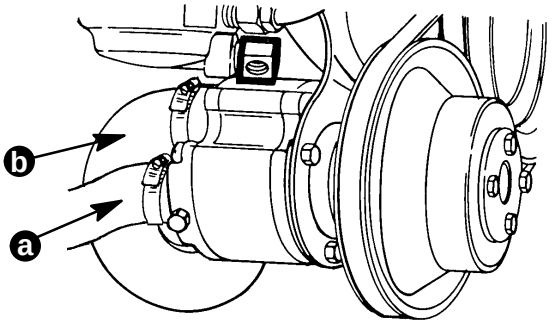
a - Speedometer Pitot Tube
b - Trim Tab Cavity Vent Hole
c - Trim Tab Cavity Drain Passage

10. Remove seawater pump inlet hose as shown.



With Combination Seawater / Mechanical Fuel Pump

a - Seawater Inlet Hose
b - Hose To Cooler



Without Mechanical Fuel Pump

a - Seawater Inlet Hose
b - Hose To Cooler

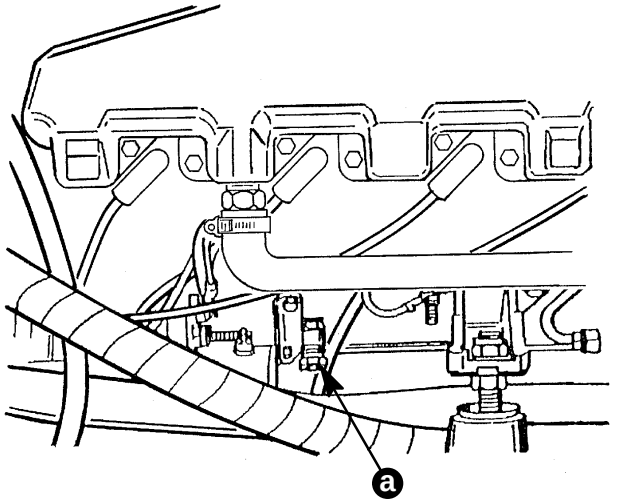
11. Crank engine over SLIGHTLY with starter motor to purge any water trapped in seawater pickup pump. DO NOT ALLOW ENGINE TO START.
12. After cooling system has been drained completely, install and tighten securely all petcocks or drain plugs. Reconnect all hoses and tighten all hose clamps securely.

MIE (Inboard) Models

NOTICE

Refer to "Draining Precautions," in this section, BEFORE proceeding.

1. Engine must be level or front of engine slightly higher to properly drain cooling system.
2. Remove drain plugs (port and starboard) from cylinder block.



Starboard Side Shown (Port Similar)

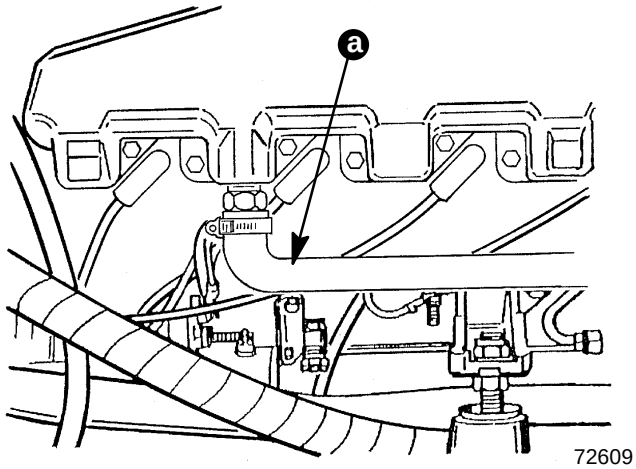
a - Drain Plug

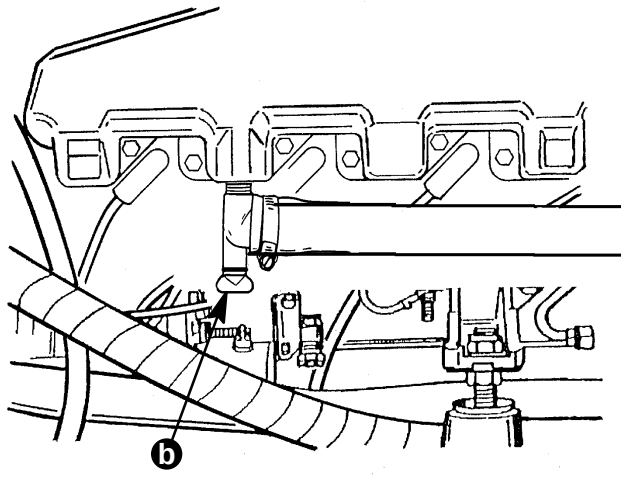
3. Repeatedly clean out drain holes using a stiff piece of wire. Do this until entire system is drained.

NOTE: *It may be necessary to lift, bend, or lower hoses to allow water to drain completely when hoses are disconnected.*

4. Remove hose or drain cock from bottom of port and starboard manifolds.

NOTE: *With the engine level, sufficient draining of manifolds will occur when exhaust manifold-to-thermostat housing hoses are removed.*

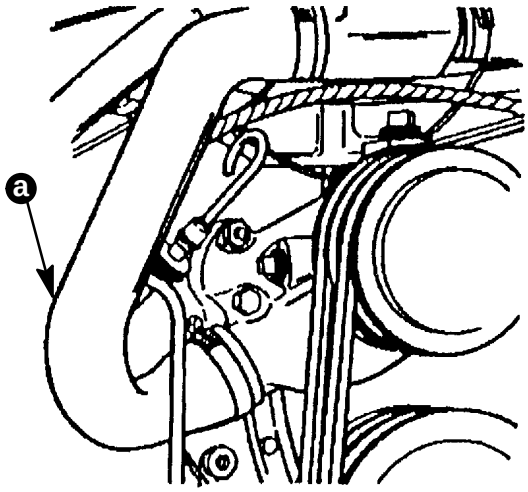




Starboard Side Shown (Port Similar)

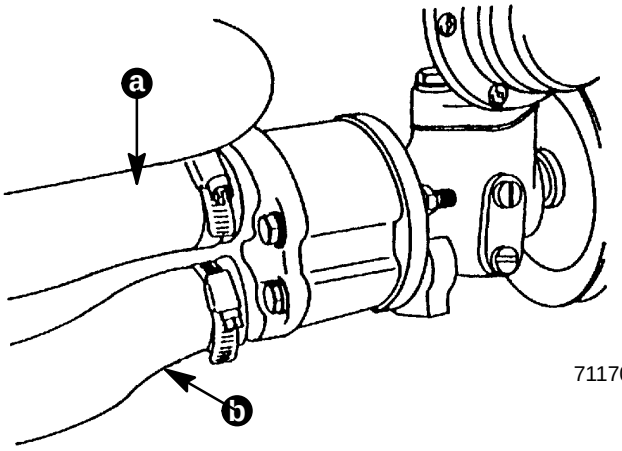
a - Bottom Hose, Exhaust Manifold To Thermostat Housing
a - Drain Plug

5. Remove the engine water circulating pump hose as shown.



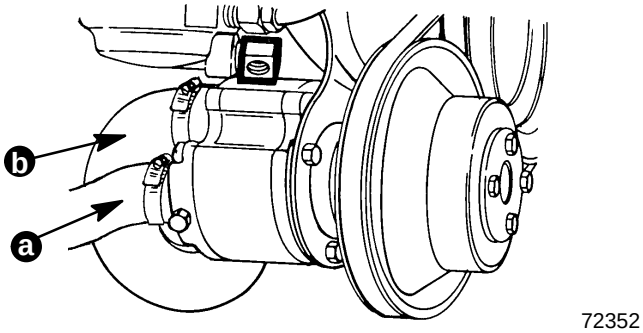
a - Hose, Water Circulating Pump To Thermostat Housing

6. Remove seawater inlet hose from seawater pump as shown.



With Mechanical Fuel Pump

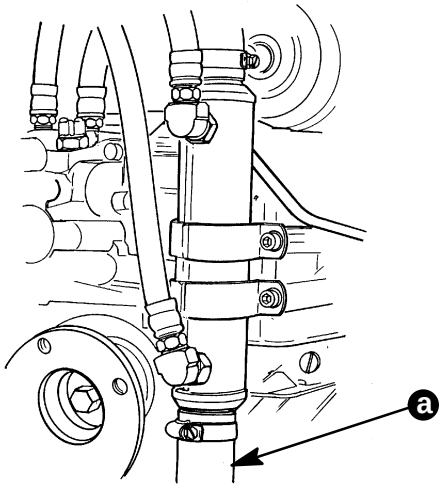
a - Seawater Inlet Hose
b - Hose To Cooler



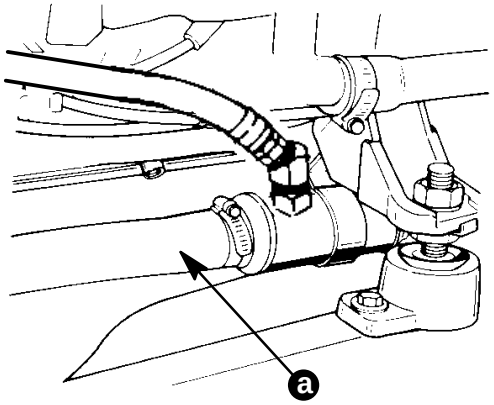
Without Mechanical Fuel Pump

a - Seawater Inlet Hose
b - Hose To Cooler

7. Remove the transmission fluid cooler hose as shown.



72721



71782

Typical Transmission Fluid Cooler Locations

a - Hose

8. Crank engine over SLIGHTLY, with starter motor, to purge any water trapped in seawater pickup pump. DO NOT ALLOW ENGINE TO START.
9. After cooling system has been drained completely, install and tighten securely all petcocks and drain plugs. Reconnect all hoses and tighten all hose clamps securely.

Auxiliary Hot Water Heater Installation

IMPORTANT: When connecting a cabin heater or hot water heater, certain requirements must be met:

- **Supply hose (from engine to heater) and return hose (from heater to engine) MUST NOT EXCEED 5/8 in. (15.8 mm) I.D. (inside diameter).**
- **Make heater connections ONLY at locations described in the following instructions.**
- **Check complete system for leaks after heater is connected into cooling system.**
- **Check for overheating condition (of engine) after heater is connected.**

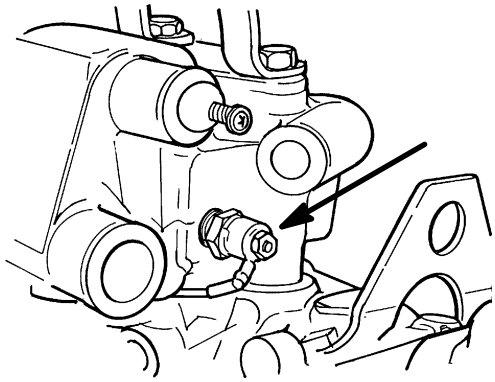
1. Hot water heater supply hose can be connected at several different locations. On some models, there may be other accessories and options that are using these hot water supply locations. One of the following should be available for use when installing a hot water heater system.

   a. Port side of thermostat housing.

NOTE: *On some models it may be necessary to remove the audio warning heat switch from port side of thermostat housing and reposition to water circulating pump opening as outlined following.*

   b. Starboard side of thermostat housing, unless being used for engine temperature switch

IMPORTANT: Do not reposition engine temperature switch, it must remain where installed by factory.



72613

Thermostat Housing - Port Side Shown (Starboard Similar)

2. Connect hot water heater SUPPLY hose to desired location following instructions “a” or “b”:

   a. **On Models with Pipe Plug in Thermostat Housing (Port or Starboard):**

      (1) Remove pipe plug.

      (2) Coat threads of fitting(s) (obtained locally) with Quicksilver Perfect Seal and install fitting(s) in threaded hole from which pipe plug was removed.

      (3) Connect hot water heat supply hose to fitting and secure with a hose clamp (not provided).

   b. **On Models with Audio Warning Heat Switch in Thermostat Housing (Port Side):**

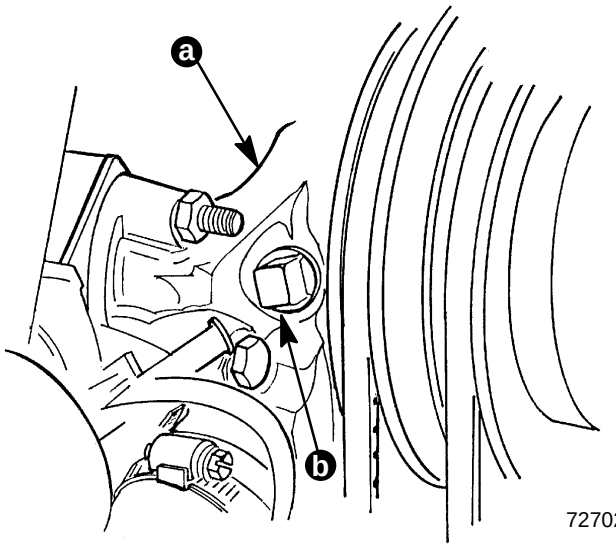
      (1) Disconnect tan/blue wire from audio warning switch.

      (2) Remove audio warning switch from thermostat housing.

      (3) Coat threads of fitting(s) (obtained locally) with Quicksilver Perfect Seal and install fitting(s) in threaded hole from which pipe plug was removed.

      (4) Connect hot water heater supply hose to fitting and secure with a hose clamp (not provided).

      (5) Remove pipe plug from starboard side of engine water circulating pump.



72702

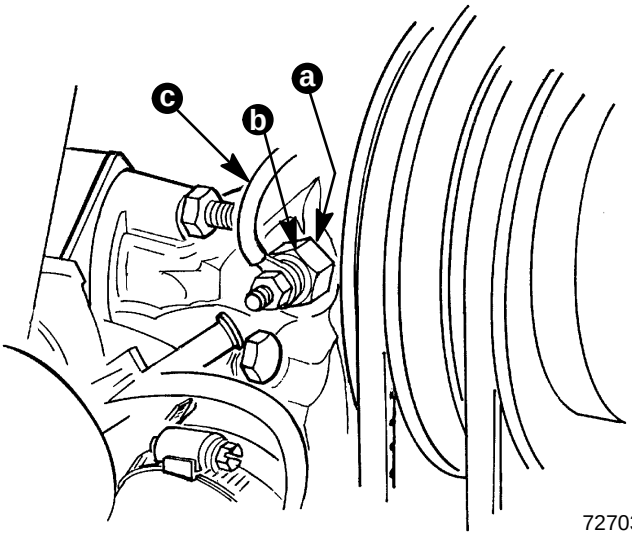
a - Engine Water Circulating Pump
b - Pipe Plug

      (6) Apply Loctite Pipe Sealant with Teflon to threads of reducer bushing (obtain locally) and audio warning heat switch.

      (7) Install reducer bushing in circulating pump and tighten sec

(8) Install audio warning switch in reducer bushing and tighten securely.

(9) Connect tan/blue wire to switch and secure with nut and lockwasher. Coat terminal with Quicksilver Liquid Neoprene.

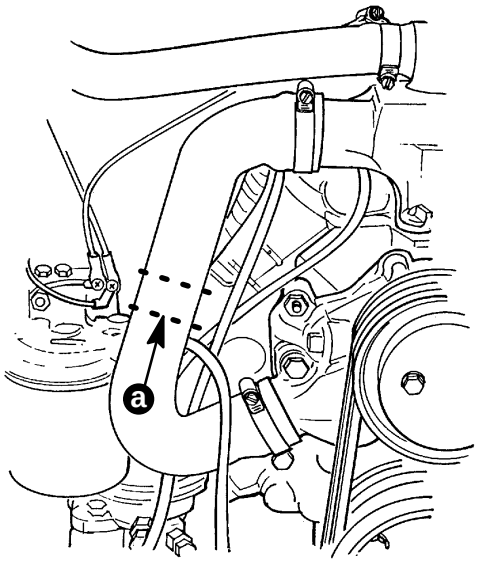


72703

b - Reducer Bushing (Hidden In This View)
c - Audio Warning Heat Switch
d - TAN / BLUE Wire

3. Connect hot water heater return hose into system as follows (refer to figures):

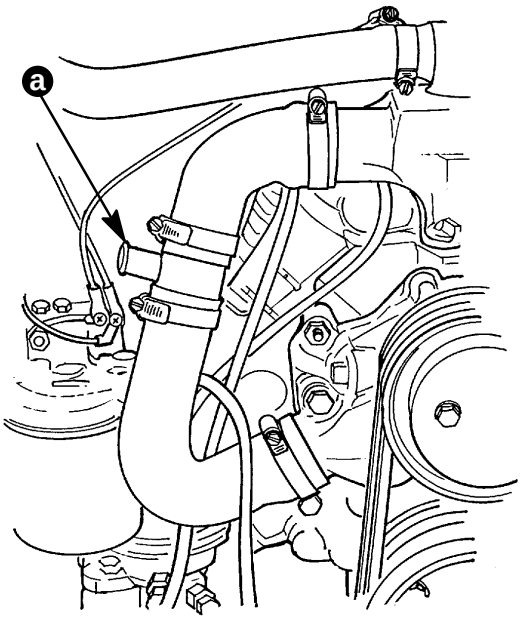
   a. Cut approximately 3/4 in. (19 mm) out of hose to maintain proper hose configuration.



72704

a - Cut Here

   b. Secure T-fitting in hose with hose clamps (provided in kit) and tighten securely.



72705

a - T- Fitting

   c. Connect hot water heater return hose to T-fitting and secure with hose clamp (provided).

4. Secure hoses, as required, to ensure they do not rub or chafe against engine components.

5. With boat in water, start engine and check for leaks and overheating.

Installation

Refer to the illustrations on the following pages for specific supply and return hose connection points.

MCM 7.4LX EFI, AND MIE 7.4L EFI ENGINES

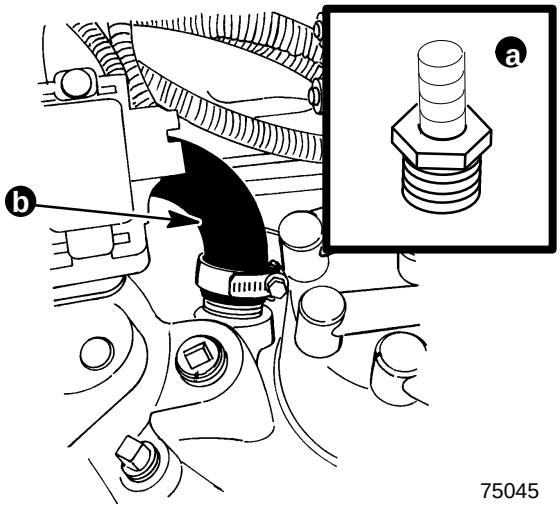
IMPORTANT: When connecting a cabin heater or hot water heater on these engines, the following additional requirements must be met:

- **DO NOT install any valves, or similar devices, which could restrict or stop the flow of supply and return coolant from a cabin heater and/or hot water heater.**
- **DO NOT install T-fittings, or similar devices, in the existing intake manifold-to-engine water circulating pump hose. This hose must be removed and discarded.**

⚠ CAUTION

Avoid a performance loss and/or possible engine damage. Engine coolant must flow continuously from the engine intake manifold to the engine water circulating pump. NEVER close-off or block the coolant flow to or from a heater.
All heater installations must be plumbed in series with the supply and return connections.

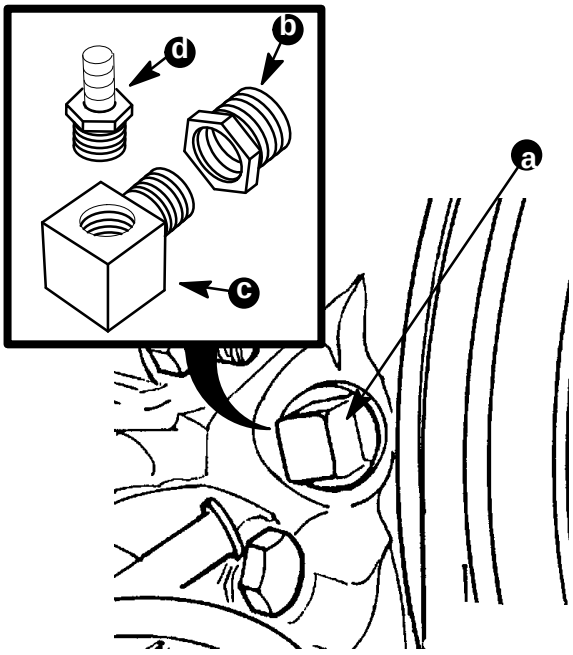
1. Remove and discard the existing hose that is connected from the fitting at the aft side of the intake manifold to the water circulating pump.
2. **If engine is equipped with a fitting that is smaller than 5/8 in. (16 mm) I.D.,** remove the fitting and apply Quicksilver Perfect Seal to threads and install fitting from kit.
3. The heater supply hose can then be connected to the fitting at the aft side of the intake manifold.



a - Hose Connector
b - Connect Supply Hose Here

4. **If engine is equipped with a fitting at the circulating pump that is smaller than 5/8 in. (16 mm) I.D.,** remove the fitting and apply Quicksilver Perfect Seal to threads and install return hose connector from kit, as follows:
   a. Remove the plug from circulating pump.
   b. Install reducer bushing into circulating pump.
   c. Install 90 degree fitting into reducer bushing.
   d. Install hose connector into 90 degree fitting.

e. Connect heater return hose to connector and tighten securely.



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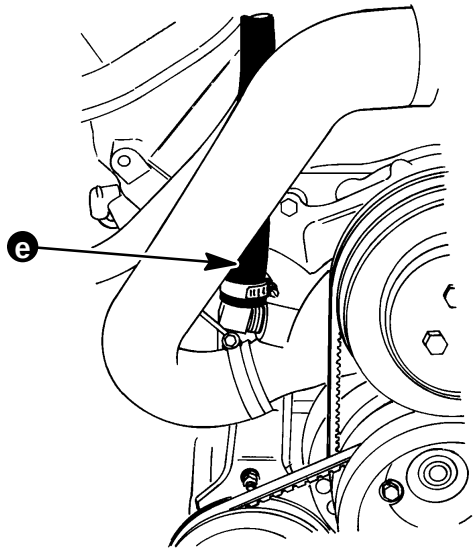
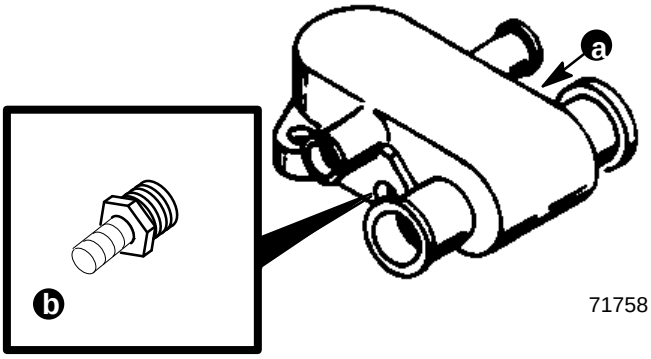


75075

a - Plug
b - Reducer Bushing
c - 90 Degree Fitting
d - Hose Connector
e - Connect Return Hose from Heater Here

MCM 454 AND 502 MAGNUM MPI ENGINES

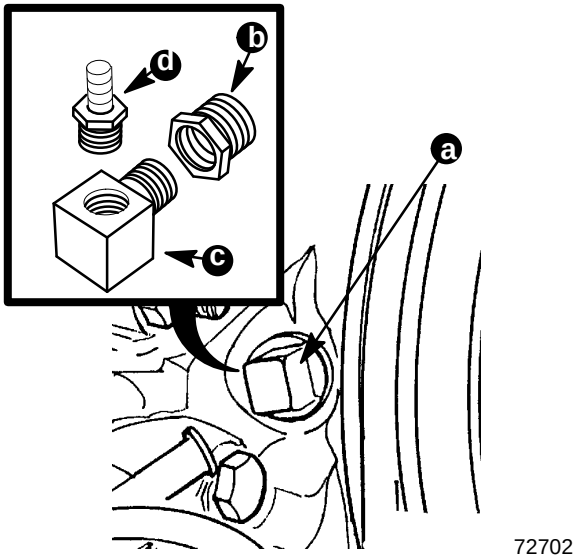
1. Remove the plug from the starboard side of thermostat housing.
2. Apply Quicksilver Perfect Seal to threads and install the supply hose connector into thermostat housing. Tighten securely.



71758

a - Thermostat Housing
b - Hose Connector

3. Apply Quicksilver Perfect Seal to threads and install return hose connector as follows:
   a. Remove the plug from circulating pump.
   b. Install reducer bushing into circulating pump.
   c. Install 90 degree fitting into reducer bushing.
   d. Install hose connector into 90 degree fitting.



72702

a - Plug
b - Reducer Bushing
c - 90 Degree Fitting
d - Hose Connector

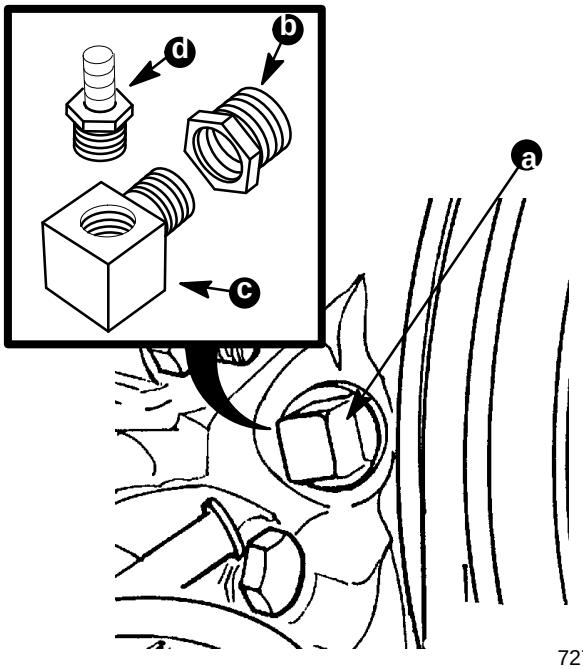
4. Connect hoses to supply and return fittings in accordance with heater manufacturer's instructions.

a. **On 454 CID V8 Models** - Install return hose fittings as follows:

(1) Install reducer bushing into circulating pump.

(2) Install 90 degree fitting into reducer bushing.

(3) Install hose connector into 90 degree fitting.



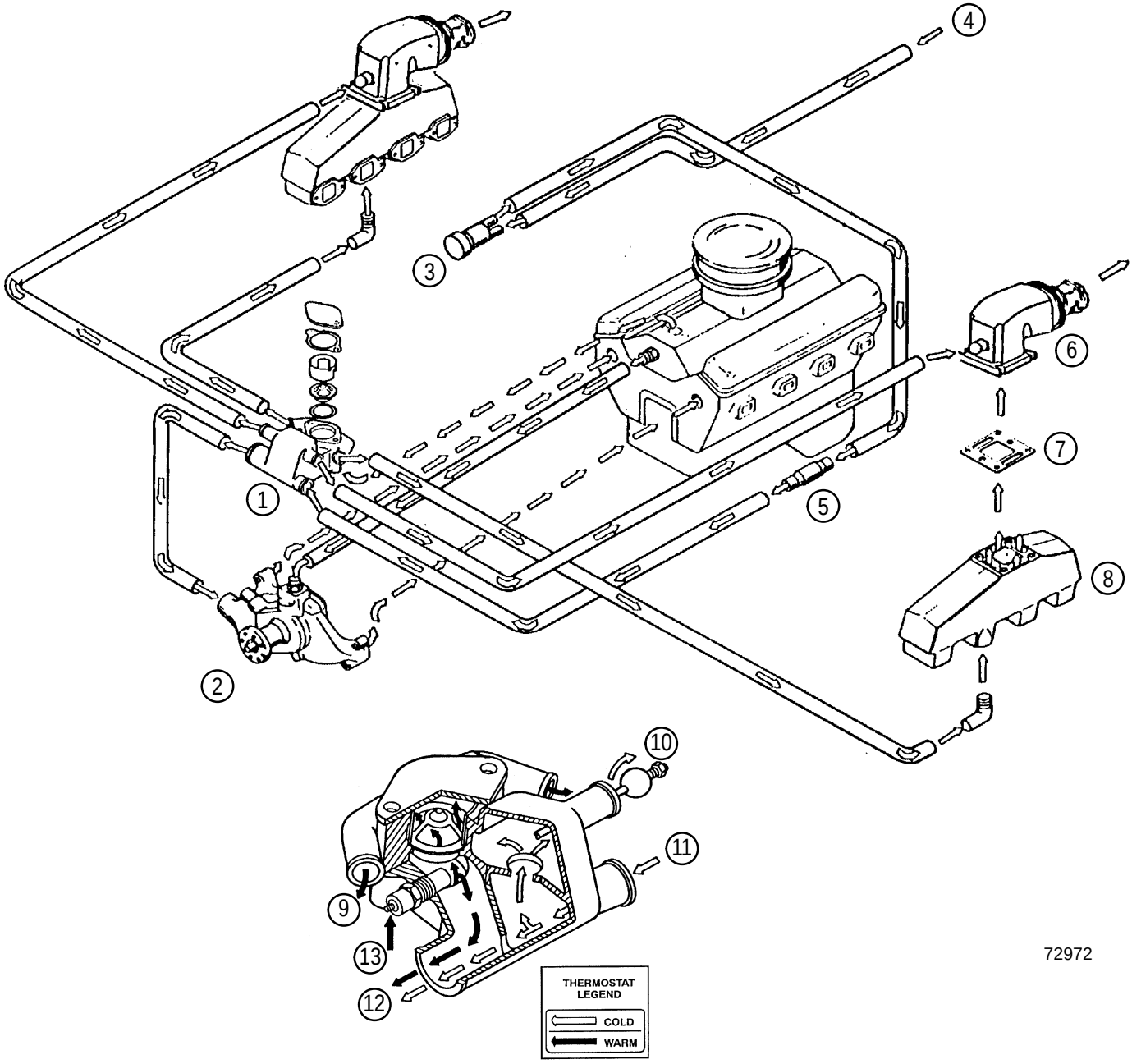
72702

a - Plug
b - Reducer Bushing
c - 90 Degree Fitting
d - Hose Connector

5. Connect hoses to supply and return fittings in accordance with heater manufacturer's instructions.
6. Connect hot water heater return hose to T-fitting and secure with hose clamps (provided).
7. Secure hoses, as required, to ensure they do not rub or chafe against engine components.
8. With boat in water, start engine and check for leaks and overheating.

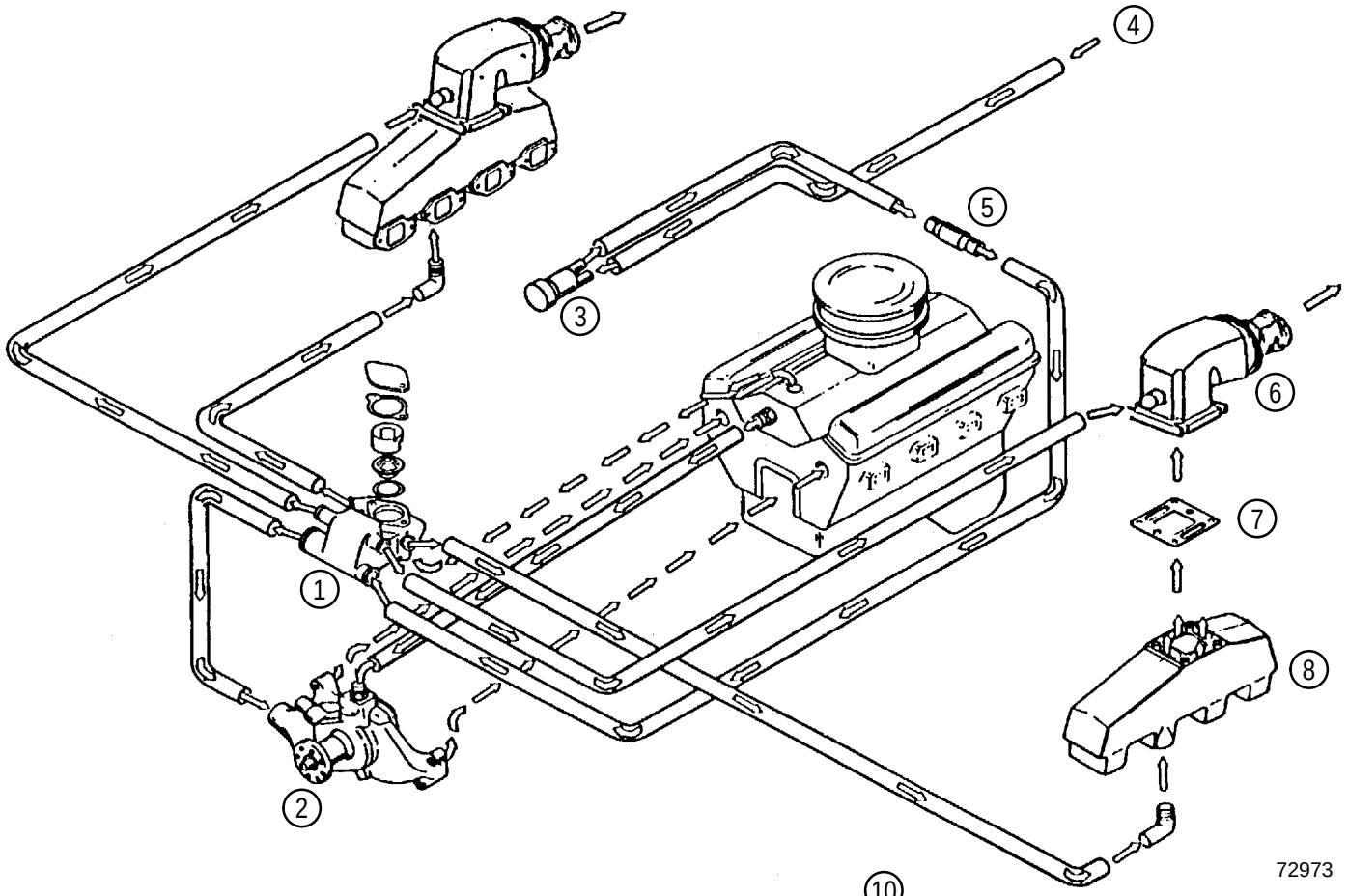
Water Flow Diagrams

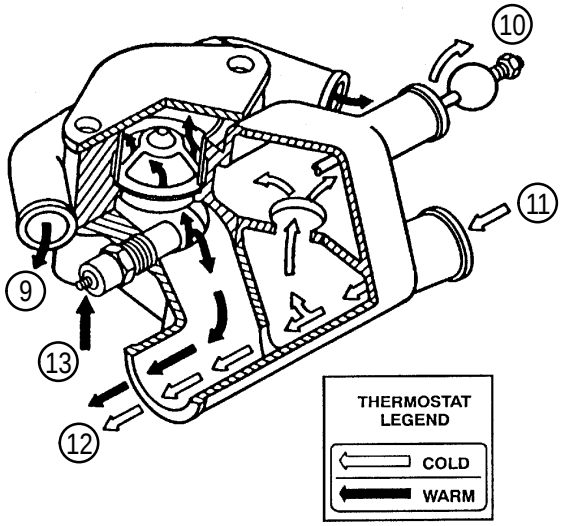
MCM7.4L / 454 Magnum



1 - Thermostat Housing
2 - Engine Circulating Pump
3 - Seawater Pickup Pump
4 - Seawater Inlet
5 - Engine Oil and Power Steering Fluid Cooler
6 - Exhaust Elbow
7 - Restrictor
8 - Exhaust Manifold
9 - To Exhaust Manifolds
10- To Exhaust Elbows
11- Form Water Inlet (Via Fluid Cooler)
12- To Engine Circulating Pump
13- From Engine

MCM 502 Magnum





1 - Thermostat Housing
2 - Engine Circulating Pump
3 - Seawater Pickup Pump
4 - Seawater Inlet
5 - Engine Oil and Power Steering Fluid Cooler
6 - Exhaust Elbow
7 - Restrictor
8 - Exhaust Manifold
9 - To Exhaust Manifolds
10- To Exhaust Elbows
11- Form Water Inlet (Via Fluid Cooler)
12- To Engine Circulating Pump
13- From Engine

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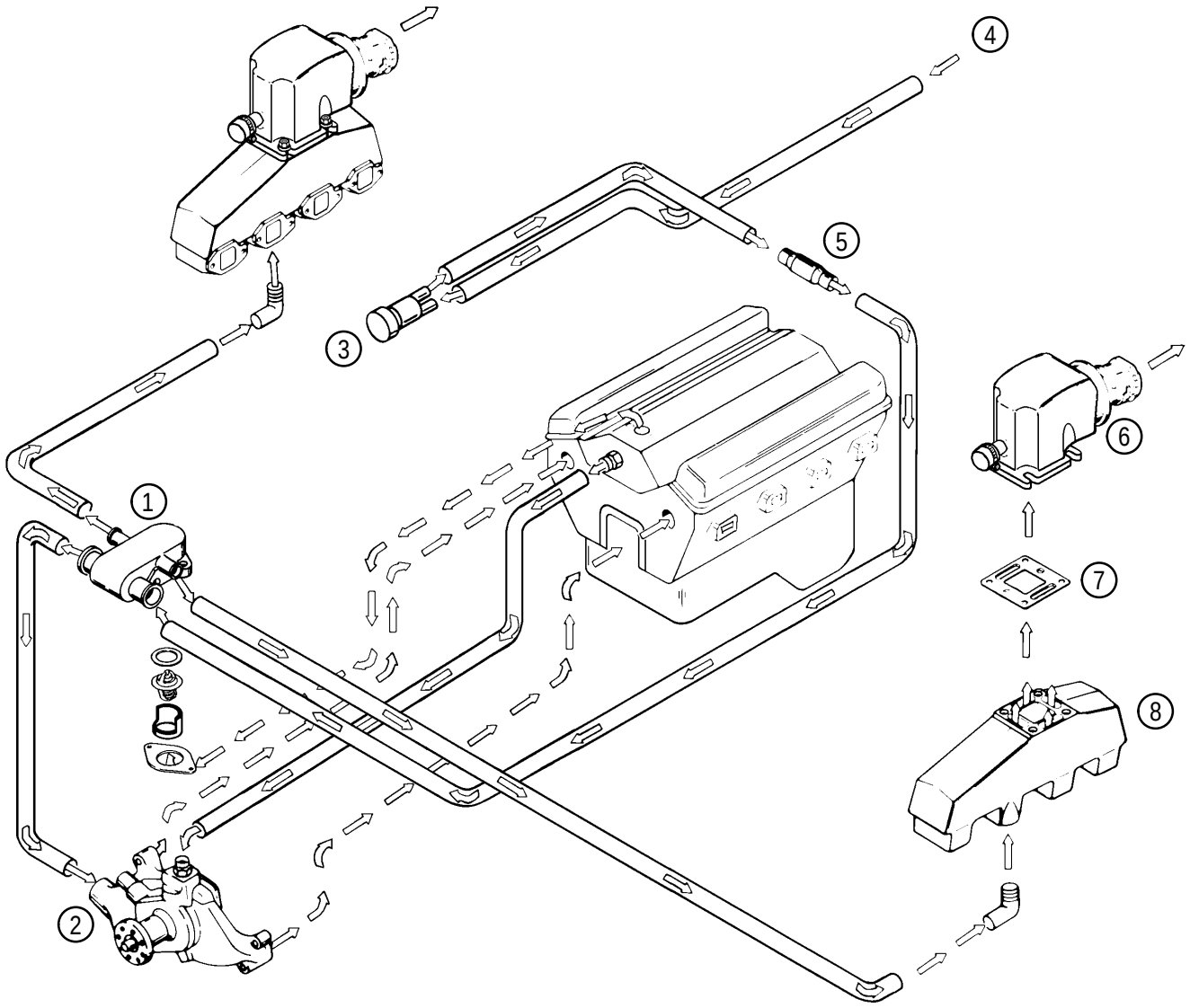
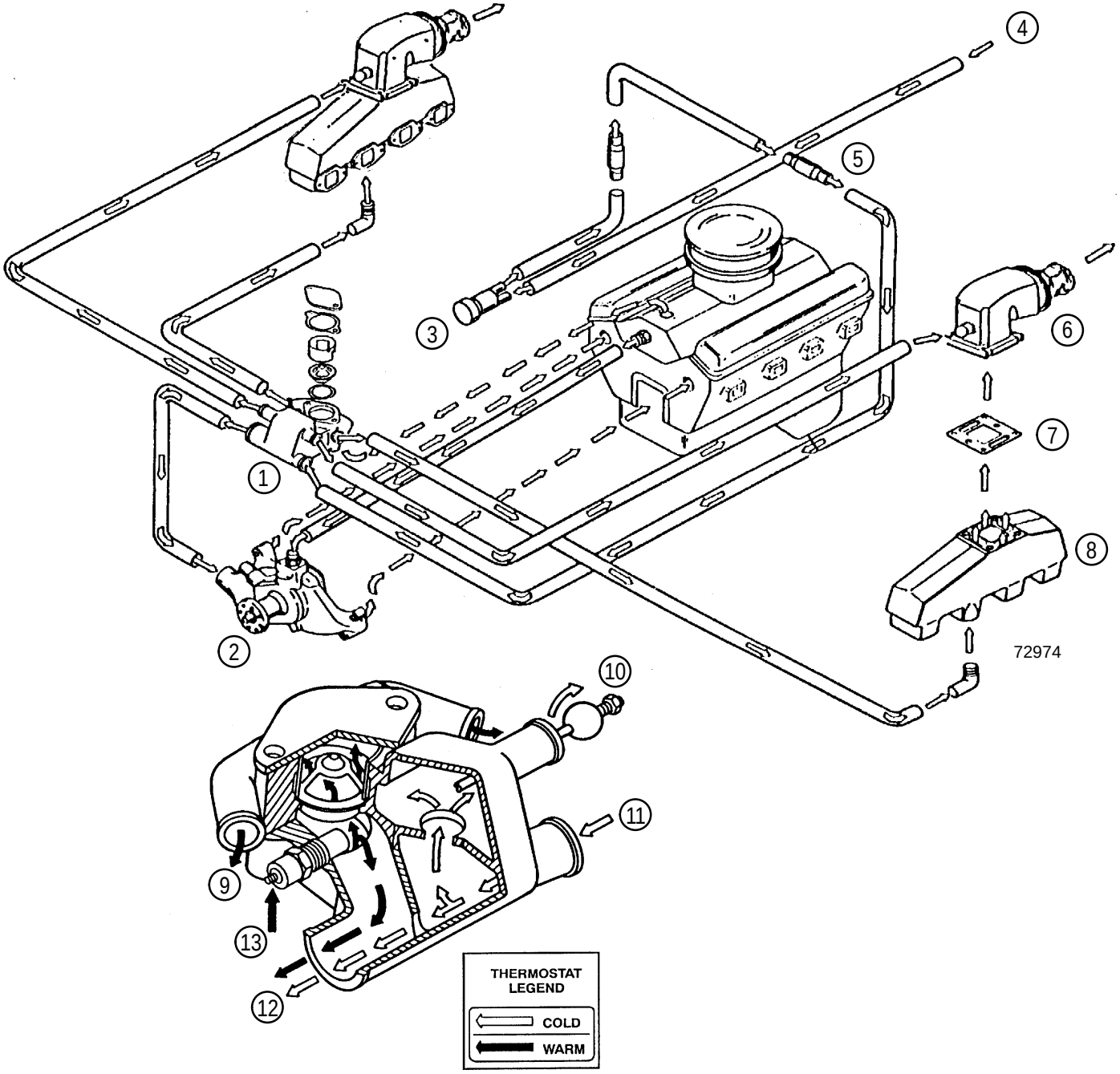
MCM / MIE Models With Stainless Steel Thermostat Housing



71694

1 - Thermostat Housing
2 - Engine Circulating Pump
3 - Seawater Pickup Pump
4 - Seawater Inlet
5 - Engine Oil Cooler
6 - Exhaust Elbow
7 - Restrictor
8 - Exhaust Manifold

MIE 7.4L/8.2L Inboard



1 - Thermostat Housing
2 - Engine Circulating Pump
3 - Seawater Pickup Pump
4 - Seawater Inlet
5 - Engine Oil Cooler
6 - Exhaust Elbow
7 - Restrictor
8 - Exhaust Manifold
9 - To Exhaust Manifolds
10- To Exhaust Elbows
11- Form Water Inlet (Via Fluid Cooler)
12- To Engine Circulating Pump
13- From Engine

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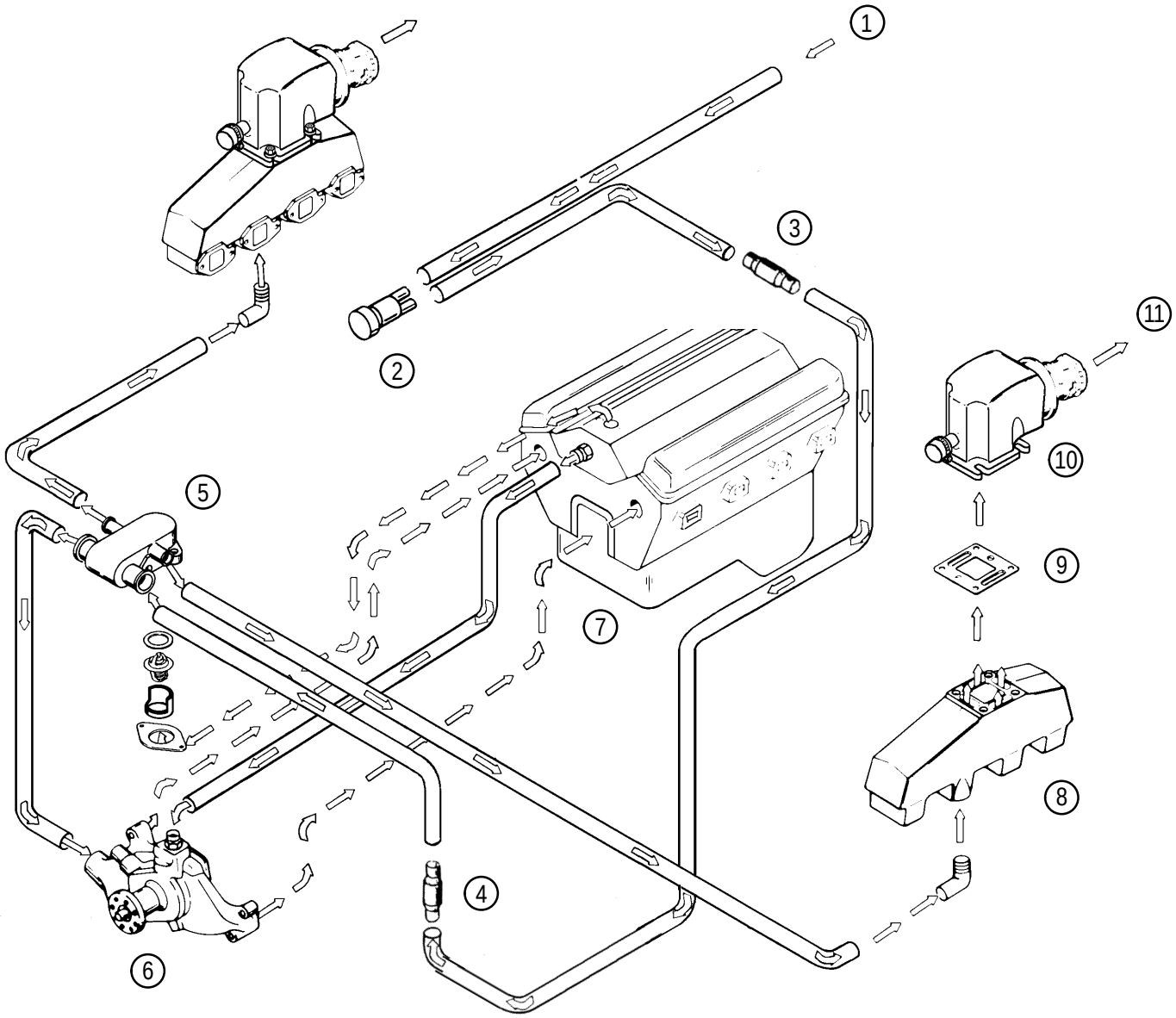
7.4L/454 Magnum/7.4LX Multi-Port Injection /454 Magnum Multi-Port Injection / 502 Magnum Multi-Port Injection Bravo and Blackhawk Engines



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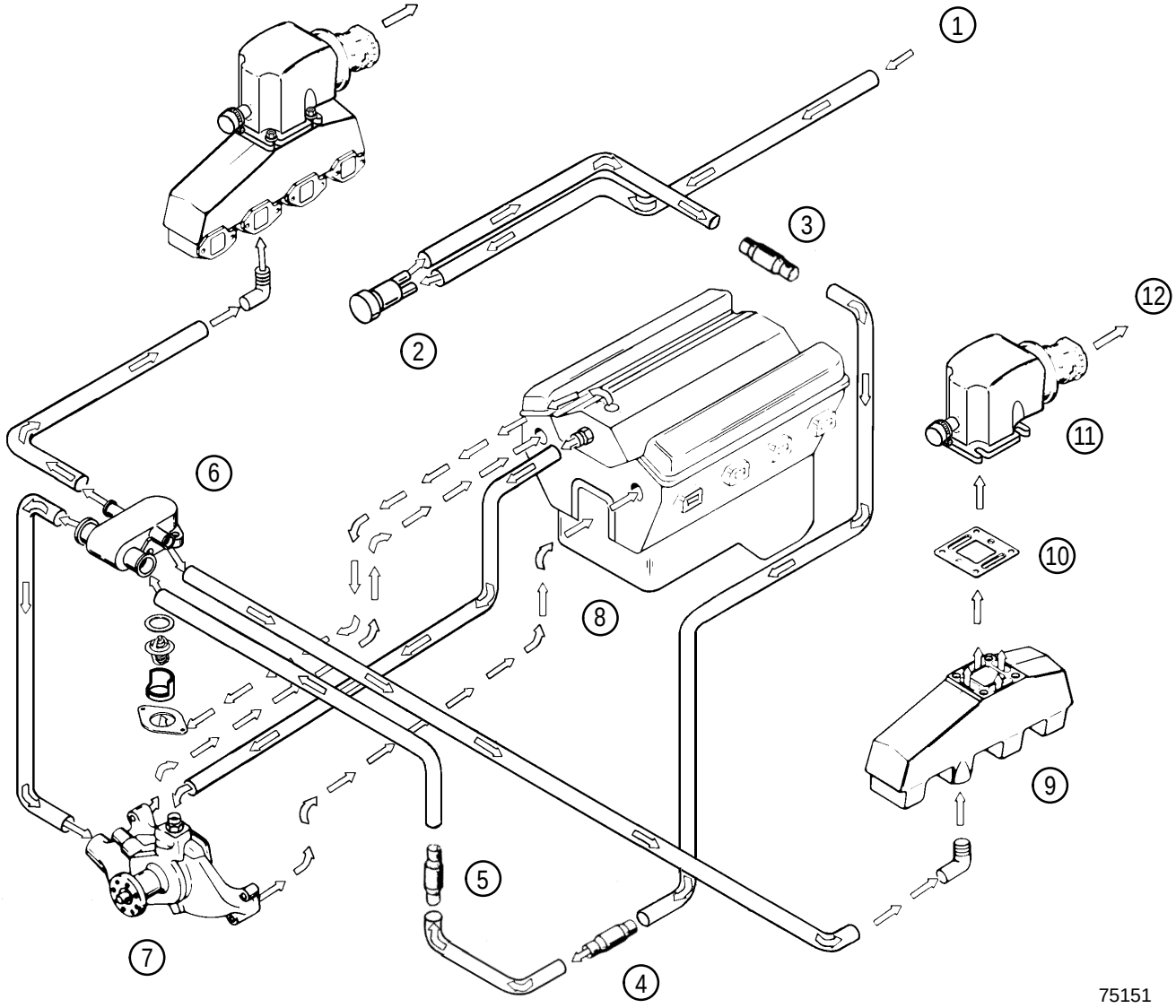
NOTE: *Certain components in the following diagram may look different than on your particular power package, but the water flow paths remain similar on all engines.*

1 - Seawater Intake (From Stern Drive)
2 - Seawater Pump
3 - Power Steering Cooler, If Equipped
4 - Engine Oil Cooler
5 - Thermostat Housing and Cover Assembly
6 - Engine Water Circulating Pump
7 - Engine Block and Cylinder Head Assembly
8 - Exhaust Manifold, Typical
9 - Restrictor Gasket
10- Exhaust Elbow Assembly, Typical
11- Water Flow Overboard

7.4LX Throttle Body Injection Bravo Engines



NOTE: *Certain components in the following diagram may look different than on your particular power package, but the water flow paths remain similar on all engines.*

1 - Seawater Intake (From Stern Drive)
2 - Seawater Pump
3 - Power Steering Cooler, If Equipped
4 - Fuel Cooler
5 - Engine Oil Cooler
6 - Thermostat Housing and Cover Assembly
7 - Engine Water Circulating Pump
8 - Engine Block and Cylinder Head Assembly
9 - Exhaust Manifold, Typical
10- Restrictor Gasket
11- Exhaust Elbow Assembly, Typical
12- Water Flow Overboard

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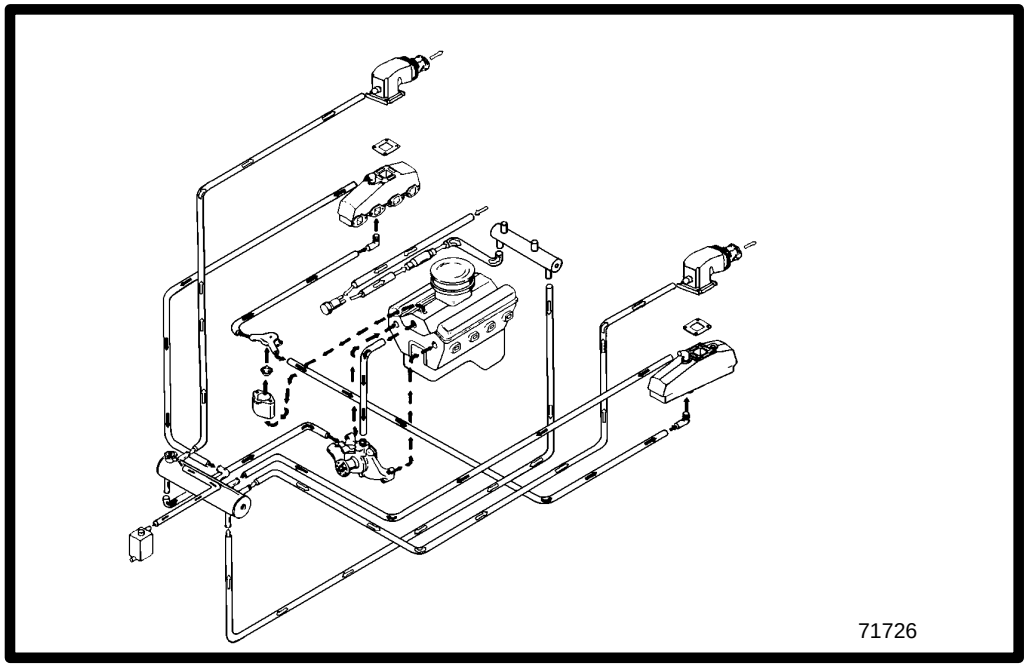
COOLING SYSTEM



6

B

CLOSED COOLED MODELS

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Torque Specifications

Fastener Location	Lb. In.	Lb. Ft.	N·m
Heat Exchanger End Cap	36-72		4-8
Thermostat Cover	30		41
Heat Exchanger Mounting Brackets	Securely		
Hose Clamps			
Drain Plugs			

Lubricants/Sealants

Description	Part Number
Quicksilver 2-4-C Marine Lubricant With Teflon	92-825407A3
Quicksilver Perfect Seal	92-34227-1
Quicksilver Liquid Neoprene	92-25711-2
Loctite Pipe Sealant With Teflon	Obtain Locally

Specifications

Closed Cooling System Capacity

MODEL	MCM AND MIE 454 CID / 7.4L	MCM AND MIE 7.4L MPI	MCM AND MIE 502 CID / 8.2L
Seawater Cooling System[2]	20 (19)		
Closed Cooling System	28 (26.5) [1] 18 (17) [2]	18 (17) [2]	28 (26.5) [2]

[1] Closed cooling system with manifolds included in coolant side of system.

[2] Closed cooling system without manifolds included in coolant side of system.

Thermostat

Engine	Specification
Engines With Thunderbolt IV Ignition	143°F (62°C)
Engines With Thunder-bolt V Or Fuel Injection	160°F (71°C)

Pressure Cap Rating

Engine	Specifications
All Engines	16 PSI (110 kPa)_

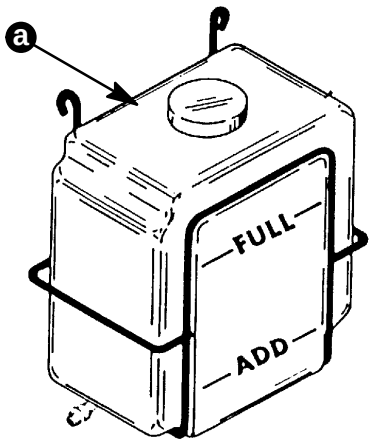
Description

There are several configurations of this cooling system, but the operation is essentially identical. Basically, the system is composed of two separate subsystems: the seawater system and the closed cooling system. The seawater system is similar in function to the fan used in an automobile because it absorbs heat (from the closed cooling system) as it passes through the heat exchanger. The closed cooling system is similar in function to the rest of the cooling system in an automobile.

The coolant recovery system keeps the reservoir full. Normal coolant overflow into recovery bottle is approximately 1/2 pint (230 mL) during warm-up. The coolant recovery system draws coolant back into the reservoir from the recovery bottle as the engine cools. As long as there is coolant in the recovery bottle, the reservoir should remain completely full. If not, there's a vacuum leak, usually at the hose leaving the reservoir, or the gasket under the recovery filler cap. The gasket seals against the outer rim of the filler neck.

IMPORTANT: The coolant (antifreeze) flows around the outside of the cooling tubes while seawater flows through the inside of the cooling tubes in the heat exchanger.

Maintaining Coolant Level



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Coolant Recovery Bottle

a - Fill Cap

Before starting engine each day, check to ensure that coolant is visible in coolant recovery bottle.

If coolant is not visible, check fresh water section of cooling system (including coolant recovery system) for leaks and repair, as necessary. Refill fresh water section with recommended coolant solution, as outlined under "Changing Coolant," following.

If coolant is visible, start engine and run until it reaches normal operating temperature, then recheck coolant level in coolant recovery bottle. Coolant level MUST BE between the ADD and FULL marks (on front of bottle).

⚠WARNING

Allow engine to cool before removing pressure cap, as sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled, turn cap 1/4 turn to allow any pressure to escape slowly, then push down and turn cap all the way off.

If level is low, remove fill cap from coolant recovery bottle and add required amount of coolant solution. Use a 50/50 mixture of ethylene glycol antifreeze and pure, soft water for coolant additions. If frequent additions of coolant are required, check fresh water section for leaks.

IMPORTANT: ALCOHOL OR METHANOL BASE ANTIFREEZE OR PLAIN WATER ARE NOT RECOMMENDED FOR USE IN COOLING SYSTEM AT ANY TIME. In areas where ethylene glycol is not available, and the possibility of freezing does not exist, it is permissible to use a solution of rust inhibitor and pure, soft water (mixed to manufacturer's recommendations).

Occasionally, check to ensure that coolant recovery system is functioning properly by removing pressure cap from heat exchanger and checking level. Coolant level should be up to bottom of heat exchanger filler neck. If low, examine entire fresh water section (especially coolant recovery system) for leaks and repair, if necessary.

IMPORTANT: When reinstalling pressure cap, be sure to tighten it until it contacts stops on filler neck.

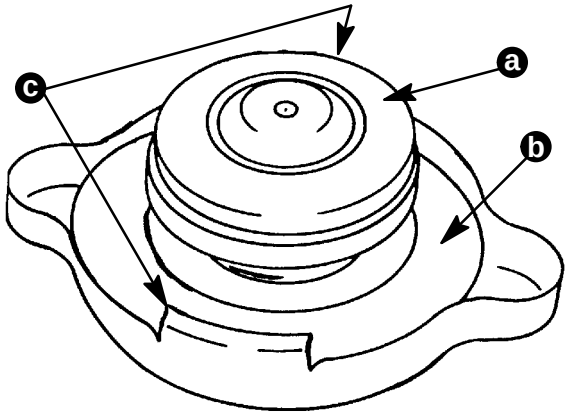
Pressure Cap Maintenance

Pressure cap is designed to maintain pressure in fresh water section of closed cooling system once the engine has attained normal operating temperature. This raises the boiling point of the coolant, thereby increasing the efficiency of the cooling system. To help ensure proper operation, cap should be cleaned, inspected and pressure tested periodically as follows:

⚠ WARNING

Allow engine to cool before removing pressure cap (in next step), as sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled, turn cap 1/4 turn to allow any pressure to escape slowly, then push down and turn cap all the way off.

1. Remove pressure cap from heat exchanger.
2. Wash cap with clean water to remove any deposits or debris from sealing surfaces.
3. Inspect rubber seal on cap for cuts, cracks or other signs of deterioration. If seal is damaged, cap MUST BE replaced.
4. Inspect coolant recovery gasket for deterioration and replace if bad.
5. Check condition of locking tabs on cap. Replace cap if tabs are bent or cracked.



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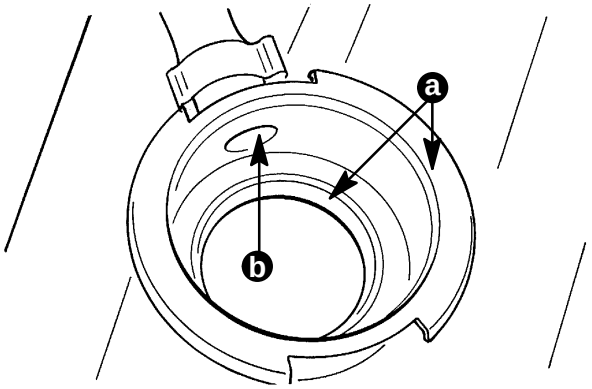
a - Rubber Seal (cap MUST BE Replaced If Damaged)
b - Gasket (Look For Cracks Under Gasket)
c - Locking Tabs (1 Hidden)

6. Refer to “Testing Pressure Cap” and test pressure cap as outlined.
7. Clean sealing surfaces on heat exchanger filler neck with a cloth. Inspect surfaces for any damage or deposits that may prevent cap from sealing properly.
8. Clean coolant recovery passage in heat exchanger filler neck with a wire and blow out with compressed air.



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a - Inspect for Damage
b - Clean Coolant Recovery Passages

9. Reinstall pressure cap, being sure to tighten until it contacts stops on filler neck.

Seawater Pickup Pump Maintenance

Whenever insufficient water flow is suspected, seawater pickup pump should be disassembled and inspected (by an authorized MerCruiser Dealer).

Heat Exchanger Repair

IMPORTANT: Braze with BCUP 2 rod or silver solder. Care must be taken not to melt other joints during repair.

1. Internal leaks can be repaired by brazing shut the ends of the leaking tube. This is only a temporary fix because usually another tube will start leaking after a short period of time and this also causes a reduction in cooling capacity. Do not close more than three tubes.
2. Nipples and drains that have been broken off the heat exchanger can be reattached by brazing.

Testing Closed Cooling System

Testing Coolant for Alkalinity

⚠WARNING

Allow engine to cool before removing pressure cap as sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled, turn cap 1/4 turn to allow any pressure to escape slowly, then push down and turn cap all the way off.

Coolant in fresh water section should be changed every two years and should be checked for alkalinity at least once between change intervals. To check coolant for alkalinity, proceed as follows:

1. Obtain pink litmus paper from a local supplier (drug store, pet shop, etc.).
2. Remove pressure cap from heat exchanger and insert one end of litmus paper into coolant.
3. **If pink litmus paper turns blue,** coolant is alkaline and need not be replaced.
4. **If pink litmus paper remains pink,** coolant is not alkaline and MUST BE REPLACED, as explained under “Changing Coolant.”

Pressure Testing System

⚠WARNING

Allow engine to cool before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled, turn cap 1/4 turn to allow any pressure to escape slowly, then push down and turn cap all the way off.

If coolant section of closed cooling system is suspected of leaking or not holding sufficient pressure, and no visible signs of leakage can be found, perform the following test:

1. Remove pressure cap from heat exchanger or reservoir.
2. Clean, inspect and pressure test pressure cap, as outlined under “Testing Pressure Cap,” to eliminate the possibility that cap is not maintaining proper pressure in system and is causing coolant to boil over.
3. Clean inside of filler neck to remove any deposits or debris. Examine lower inside sealing surface for nicks or other damage. Surface must be perfectly smooth to achieve a good seal between it and rubber seal on cap. Also check locking cams on sides of filler neck to be sure that they are not bent or damaged. If locking cams are bent or damaged, pressure cap will not hold the proper pressure.
4. Adjust coolant level in fresh water section to 1 in. (25 mm) below filler neck.
5. Attach an automotive-type cooling system pressure tester to filler neck and pressurize closed cooling section to amount specified in following chart, based on pressure cap rating for your engine.

Pressure Cap Rating	Amount of Pressure Applied to Closed Cooling System
16 PSI (110 kPa)	20 PSI (138 kPa)

6. Observe gauge reading for approximately two minutes; pressure should not drop during this time. If pressure drops, proceed with the following steps until leakage is found.
7. While maintaining specified pressure on closed cooling section, visually inspect external portion of cooling system (hoses, gaskets, drain plugs, petcocks, core plugs, circulating pump seal, etc.) for leakage. Also listen closely for bubbling or hissing, as they usually are a sure indication of a leak.
8. Refer to “Testing Heat Exchanger” in this section and test as outlined.
9. If no leakage could be found in above steps, engine is leaking internally, and it probably is due to one or more of the following: (1) loose cylinder head bolts or damaged gasket, (2) loose intake manifold bolts or damaged gasket, (3) loose exhaust elbow or distribution block retaining nuts or damaged gasket, (4) cracked or porous cylinder head or block, or (5) cracked or porous exhaust manifold. Proceed as follows until location of internal leak is found.
   a. Start engine. Re-pressurize system to previously specified amount and observe pressure gauge on tester. If needle in gauge vibrates, compression or combustion is leaking into closed cooling section from a leak in the combustion chamber. Exact cylinders, where leakage is taking place, sometimes can be found by removing spark plug w e at a time) while observing pressure g /ibra-

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tion will decrease or stop when plug wire is removed from leaking cylinder. Stop engine.

b. Remove spark plugs (one at a time) from cylinders and examine for presence of coolant. A spark plug that is perfectly clean or milky appearing is a sure indication of a leak.

c. Drain oil from engine and examine for presence of coolant. Oil usually will be milky if coolant is present. If coolant is present, remove engine from boat and drop the oil pan. With engine in the upright position, re-pressurize closed cooling section to previously specified amount and examine internal surfaces of engine to locate leak.

d. If no leakage can be found in above steps, entire engine must be disassembled and inspected for leakage.

Testing for Cylinder Head Gasket Leak

A leaking head gasket will cause combustion gas to be forced into the cooling system. The mixture of coolant and tiny air bubbles is a poor heat conductor and will overheat an engine quickly. Compression tests or cooling system pressure check normally will not detect the leak because the test pressure is far below the combustion pressures which cause the leak. An effective test is as follows:

IMPORTANT: Run boat in lake for this test. It is best to run the engine at or above cruising speed during this test. Usually a failed head gasket will not cause the engine to overheat below cruising speed.

1. Install a clear plastic hose between the reservoir and coolant recovery bottle. Use a 2-3 ft. (610-910 mm) long hose for this test.
2. Route this hose so a “U” is formed.
3. Put enough coolant into hose to fill the center 4 or 5 inches (100-130 mm) of the “U.”
4. Observe the “U” while the engine is running.
   a. **During Idle and Warm-Up:** Some coolant and/or air will leave the reservoir.
   b. **During Cruising Speed (2500-3500 RPM):** Coolant and/or air leaving the reservoir should stop after approximately five minutes running at a given RPM. A leaking head gasket will produce air bubbling through the “U,” going to the coolant recovery bottle. The frequency and size of the bubbles will depend on the size of the leak.
   c. **At Higher Speeds (4000+ RPM):** Normal operation is the same as described in “b” above. A failed head gasket will cause the bubbles to come faster and may be accompanied by violent, intermittent bursts of coolant.

It is important not to confuse normal warm-up expansion with a failed head gasket. Normal warm-up produces an intermittent flow of coolant which will stop within approximately five minutes at a given RPM. A head gasket leak will not stop because the one thing that marks a failed head gasket is the continued passage of air. This may be accompanied by violent, intermittent bursts of coolant leaving the reservoir. If coolant continues to flow (not in violent, intermittent bursts) from the reservoir at cruising speed, something else besides the head gasket is causing the engine to overheat.

Testing Heat Exchanger

FOR INTERNAL LEAK: An internal leak will cause coolant to go into the seawater circuit when pressure is put on the closed cooling circuit.

1. Remove a seawater hose from the exchanger. Do not drain the exchanger.
2. Pressurize the closed cooling circuit to 16-20 PSI (110-138 kPa) with a radiator tester.
3. If seawater begins to flow from the nipple there is a leak.

FOR BLOCKAGE:

IMPORTANT: Seawater flows THROUGH the tubes in the exchanger. Closed cooling coolant flows AROUND the tubes.

1. Remove end caps and inspect for any blockage in the seawater circuit (broken impeller blades, weeds, etc.).
2. Remove closed cooling circuit hoses and inspect the tubes just inside the nipples. Because the complete exchanger cannot be inspected, the heat exchanger should be replaced if blockage is suspected.

Testing Pressure Cap

Pressure cap is designed to maintain a pressure of approximately its rated capacity (refer to “Specifications”) in closed cooling section once engine has attained operating temperature. Cap should be cleaned, inspected and pressure-tested at regular tune-up intervals or whenever cap is suspected of maintaining improper pressure as follows:

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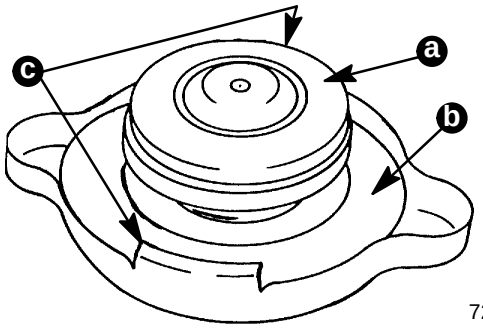
⚠ WARNING

Allow engine to cool before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled, turn cap 1/4 turn to allow any pressure to escape slowly, then push down and turn cap all the way off.

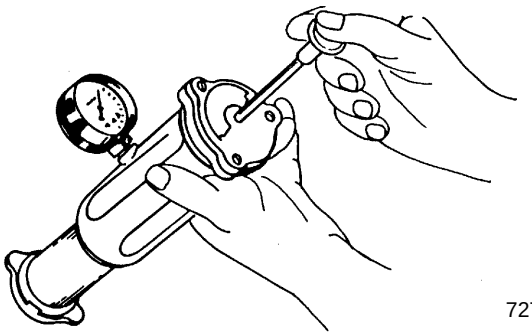
1. Carefully remove pressure cap from reservoir or heat exchanger.
2. Wash cap with clean water to remove any deposits or debris from sealing surfaces.
3. Inspect gasket (if used) and rubber seal on cap for tears, cuts, cracks or other signs of deterioration. Replace gasket, if damaged, or entire cap if rubber seal is damaged.



72714

a - Rubber Seal (cap MUST BE Replaced If Damaged)
b - Gasket (Look For Cracks Under Gasket)
c - Locking Tabs (1 Hidden)

4. Check that locking tabs on cap are not bent or damaged.
5. Using a cooling system pressure tester (similar to one shown), test cap to be sure that it releases at proper pressure and does not leak. (Refer to instructions which accompany tester for correct test procedure.) Cap must relieve pressure at 16 PSI (110 kPa), and must hold rated pressure for 30 seconds without going below 11 PSI. Replace cap if it fails to fall within these limits.



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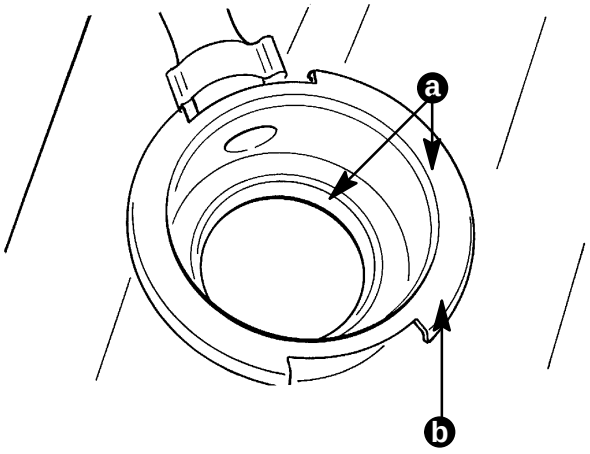
IMPORTANT: Before reinstalling cap in next step, examine lower inside sealing surface in filler neck to ensure that it is perfectly smooth and free of debris. Also, inspect cam lock flanges on sides of filler neck to be sure that they are not bent.



72715

a - Inspect For Damage
b - Cam Lock Flange

6. Reinstall cap on reservoir or heat exchanger.

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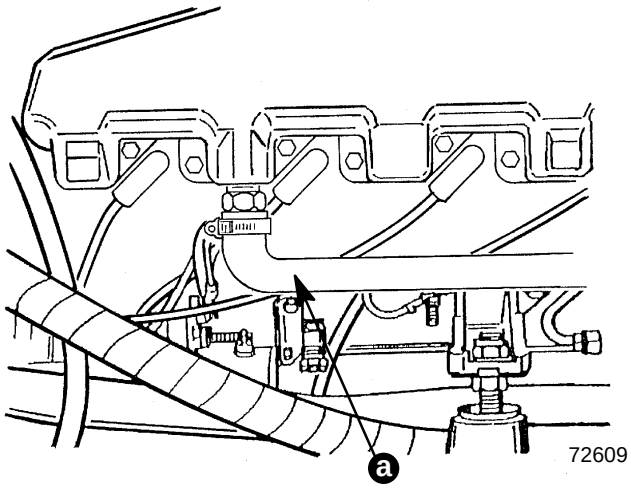
Thermostat

Removal

1. Follow instructions “a” and “b”:
   a. Drain coolant from exhaust manifolds by removing lower hose or plug from each manifold. Be sure to drain both port and starboard sides.

NOTE: *If coolant flow is restricted or fails to occur, a wire should be repeatedly inserted into all drain holes to insure there are no obstructions in passages. Remove petcock, if necessary, to insert wire completely into drain hole.*

   b. Drain engine block by removing drain plug. Be sure to drain both port and starboard sides.



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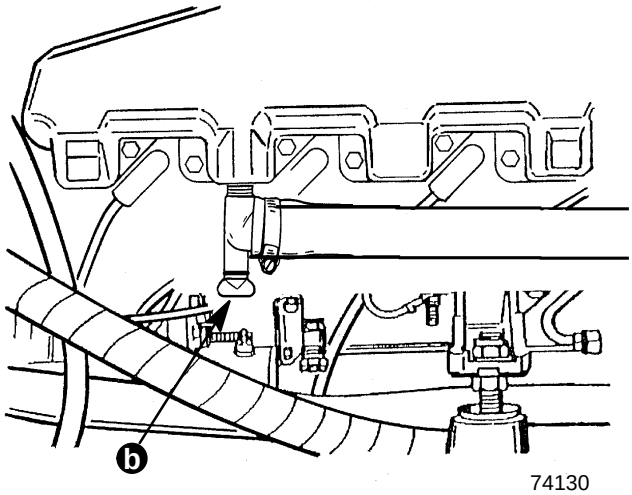
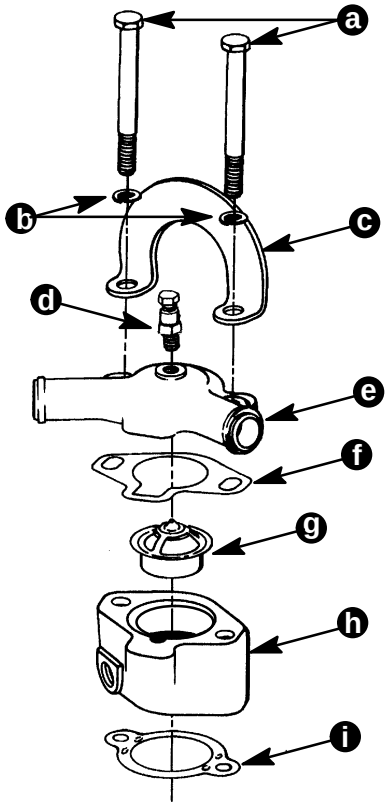


74130

Starboard Side Shown (Port Side Similar)

a - Hose
b - Drain Plug In Exhaust Manifold Elbow

2. Disconnect hoses from thermostat cover.
3. Remove thermostat cover attaching bolts and lockwashers, then remove cover and gasket.
4. Remove thermostat from thermostat housing.



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MCM Model Shown - MIE Models Not Equipped with Lifting Eye

a - Bolts
b - Lockwashers
c - Lifting Eye (MCM Models Only)
d - Hex Head Bleeder
e - Cover
f - Gasket
g - Thermostat (Typical)
h - Housing
i - Gasket With Continuity Rivets

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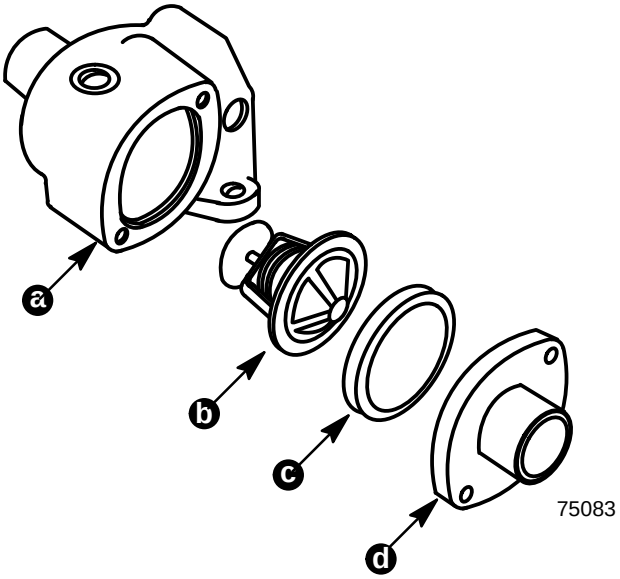
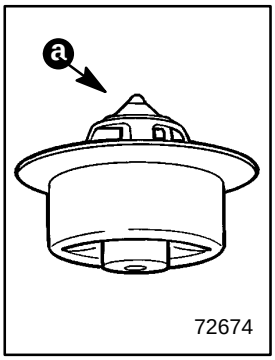


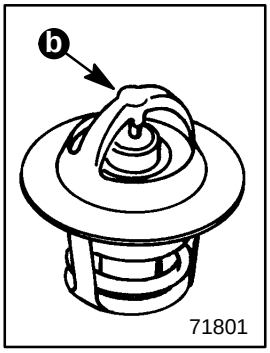
MCM / MIE Models With Seawater Flow Through Exhaust Manifolds

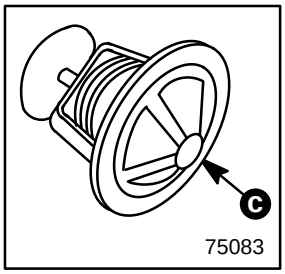
a - Thermostat Housing
b - Thermostat
c - Gasket
d - Thermostat Housing Cover

Testing

1. Clean thermostat in soap and water to remove any deposits or debris.
2. Inspect thermostat for corrosion or other visible damage.

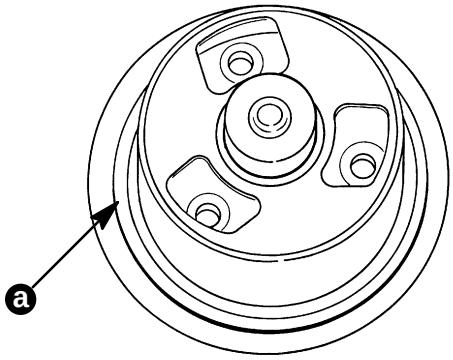






a - Brass Thermostat
b - Stainless Steel Thermostat
c - Stainless Steel Thermostat With Disc

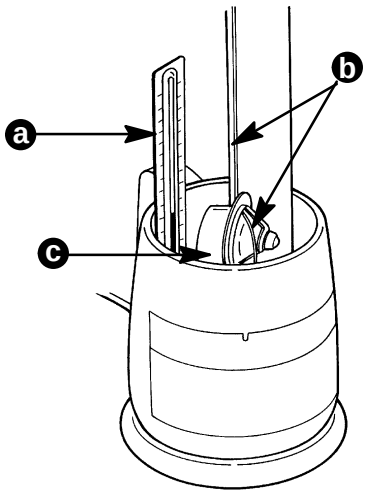
3. If thermostat is suspected of producing insufficient engine temperature, check thermostat for leakage by holding it up to lighted background. Light leakage around the thermostat valve indicates that thermostat is not closing completely and should be replaced. (A small amount of leakage at one or two points around the valve perimeter is acceptable.)



Brass Thermostat Shown (Stainless Similar)

a - Check For Light Leakage Around Perimeter Of Valve

4. Check opening and closing temperature of thermostat (using a tester similar to the one shown), as follows:
   a. Fill tester to within 1 in. (25 mm) of top with tap water. Do not use distilled water.
   b. Open thermostat valve and insert thread. Position thermostat on nylon string so that it will be just below water level when suspended, then allow valve to close. Suspend thermostat in water.



a - Thermometer
b - Nylon String
c - Thermostat (Typical)

c. Place thermometer in container and position so that bottom of thermometer is even with bottom of thermostat. Do not allow thermometer to touch container.

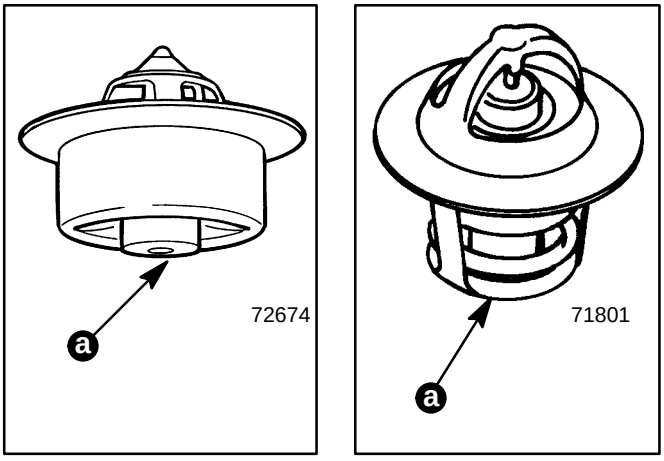
IMPORTANT: When performing instructions "d" and "e," water must be agitated thoroughly to obtain accurate results.

d. Plug in tester and observe temperature at which thermostat opens (thermostat drops off thread).

e. Unplug tester and allow water to cool to a temperature 10°F (5°C) below specified temperature on thermostat. Thermostat must be completely closed at this temperature.

f. Replace a thermostat that fails to meet all of the preceding tests.

Installation



1 - Brass Thermostat
2 - Stainless Steel Thermostat

a - Install Thermostat with This End Toward Thermostat Housing

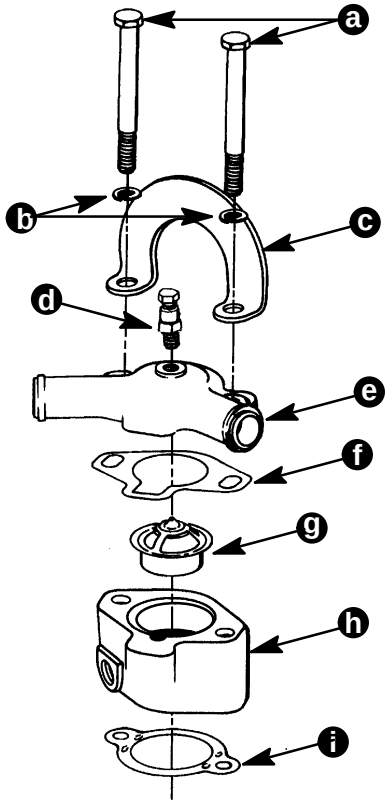
⚠CAUTION

Do not operate engine without cooling water being supplied to the seawater pickup pump, or pump impeller will be damaged.

1. Remove thermostat housing and gaskets. Discard gaskets.
2. Clean gasket surfaces on thermostat cover, thermostat housing and intake manifold.
3. Position lower gasket (with continuity rivets) on intake manifold. Place thermostat housing on gasket.

IMPORTANT: If gasket has continuity rivets, do not coat with Quicksilver Perfect Seal, or audio warning temperature switch may not work properly.

4. Install thermostat, as previously shown, into thermostat housing.
5. Position gasket on thermostat housing and reinstall thermostat cover. Torque bolts to 30 lb. ft. (41 N·m).



MCM Model Shown - MIE Models Not Equipped with Lifting Eye

a - Bolts
b - Lockwashers
c - Lifting Eye (MCM Models Only)
d - Hex Head Bleeder
e - Cover
f - Gasket
g - Thermostat (Typical)
h - Housing
i - Gasket With Continuity Rivets

6. Connect hoses to thermostat cover. Tighten hose clamps securely.

⚠CAUTION

Avoid seawater pickup pump impeller damage. DO NOT operate engine without cooling water being supplied to seawater pickup pump.

7. With boat in the water and/or cooling water properly supplied to seawater pickup pump, start engine and inspect for leaks.

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Changing Coolant

NOTICE

For information and procedures on draining the seawater cooling system of Seawater Cooled (Raw-water) Cooled Models, refer to SECTION 6A. For information and procedures on draining the Seawater Section of Closed Cooling (Coolant) Models refer to SECTION 1B. For cold weather or extended storage, refer to SECTION 1B.

Closed Cooling Section

Closed cooling section of closed cooling system should be kept filled year-round with recommended coolant solution. Do not drain closed cooling section for storage, as this will promote rusting of internal surfaces. If engine will be exposed to freezing temperatures, make sure that closed cooling section is filled with an ethylene glycol antifreeze and water solution, mixed to manufacturer's recommended proportions, to protect engine to lowest temperature to which it will be exposed. If necessary, change coolant.

Coolant Recommendations

⚠CAUTION

Alcohol or Methanol base antifreeze or plain water are not recommended for use in fresh water section of cooling system at any time.

It is recommended that the coolant section of closed cooling system be filled with 50/50 mixture of ethylene glycol antifreeze and water. In areas where the possibility of freezing DOES NOT exist, it is permissible to use solution of rust inhibitor and water (mixed to manufacturer's recommendations).

Change Intervals

Drain and flush coolant from the closed cooling system at least every two years or whenever exhaust gases have entered the system.

Draining Instructions

⚠WARNING

Allow engine to cool before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled, turn cap 1/4 turn to allow any pressure to escape slowly, then push down and turn cap all the way off.

IMPORTANT: A wire should be inserted into drain holes to ensure that foreign material is not obstructing the drain holes. On some models with two piece petcock, removal of petcock may be required so that wire can be inserted completely into drain hole.

IMPORTANT: Engine must be as level as possible to ensure complete draining of cooling system.

IMPORTANT: Closed cooling section must be kept filled year round with recommended coolant. If engine will be exposed to freezing temperatures, make sure closed cooling section is filled with an ethylene glycol antifreeze and water solution properly mixed to protect engine to lowest temperature to which it will be exposed.

IMPORTANT: Do not use Propylene Glycol Antifreeze in the closed cooling section of the engine.

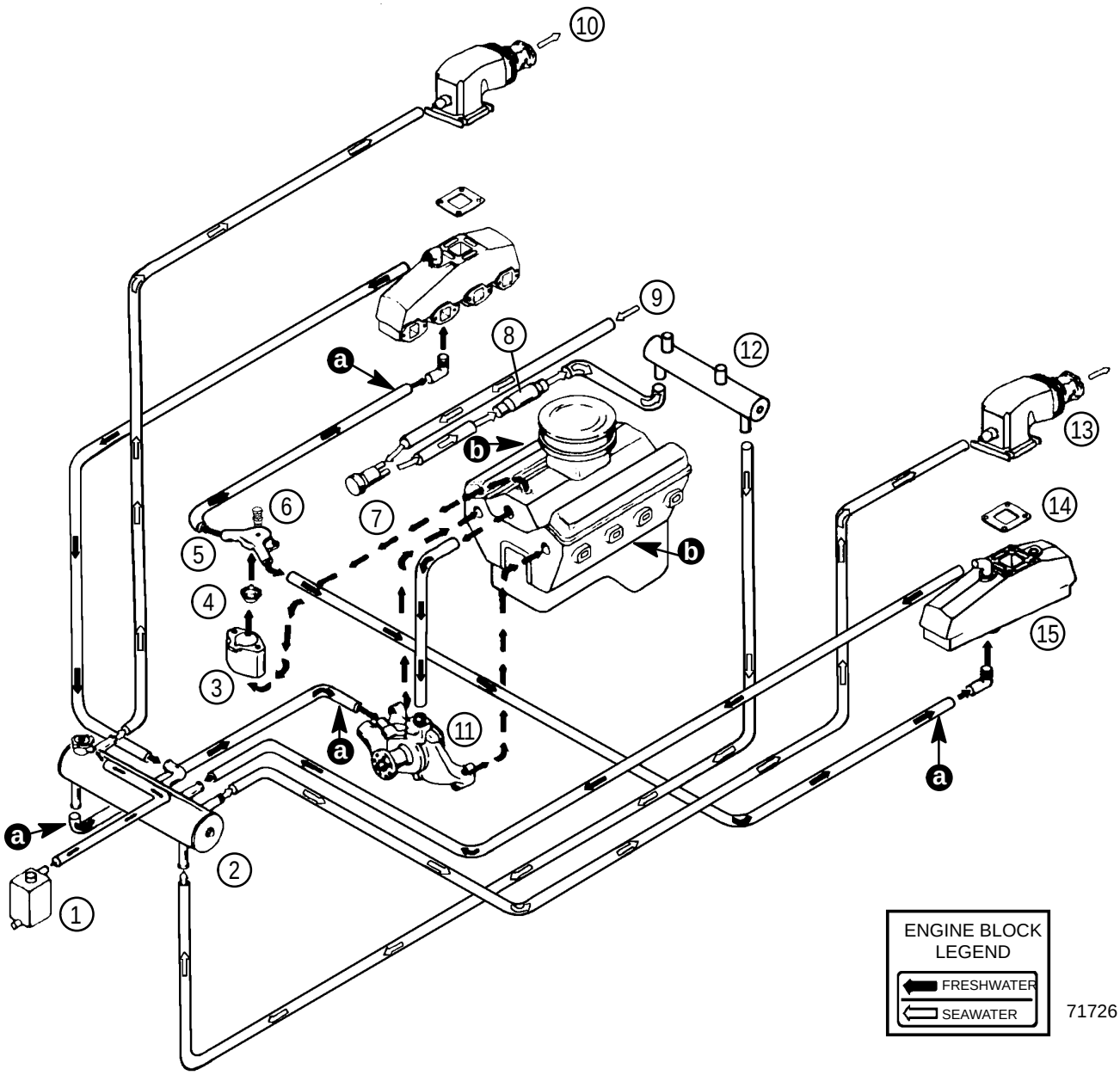
The following draining instructions apply to all engines equipped with closed cooling. The location of petcocks that require opening and hoses that require removal are represented on the following pages for the individual engines.

IMPORTANT: Observe precautions previously outlined before proceeding.

1. Remove pressure cap from coolant tank.
2. Drain coolant from locations as shown for your model and engine. (Refer to the appropriate diagram on the following "Draining Diagrams" pages.)
3. After coolant has drained completely, reinstall petcocks and hoses. Tighten clamps and petcocks securely.
4. Remove coolant recovery bottle from mounting bracket and pour out coolant.
5. Clean system as outlined in "Cleaning System."
6. Fill system as outlined in "Filling Closed Cooling Section."

Draining Diagrams - Coolant Side

FRONT MOUNTED CLOSED COOLING WITH COOLANT FLOW THROUGH EXHAUST MANIFOLDS



a - Remove Hoses (Lift, Lower or Bend To Completely Drain).
b - Remove Block Plugs (Repeatedly Clean Out Holes Using A Stiff Wire Until Entire System Is Drained).

1 - Coolant Recovery Bottle
2 - Heat Exchanger
3 - Thermostat Housing
4 - Thermostat
5 - Thermostat Housing Cover
6 - Bleeder Valve
7 - Seawater Pickup Pump
8 - Transmission Cooler
9 - Seawater Inlet
10- Overboard
11- Circulating Pump
12- Oil Cooler
13- Exhaust Elbow
14- Separator Gasket
15- Exhaust Manifold

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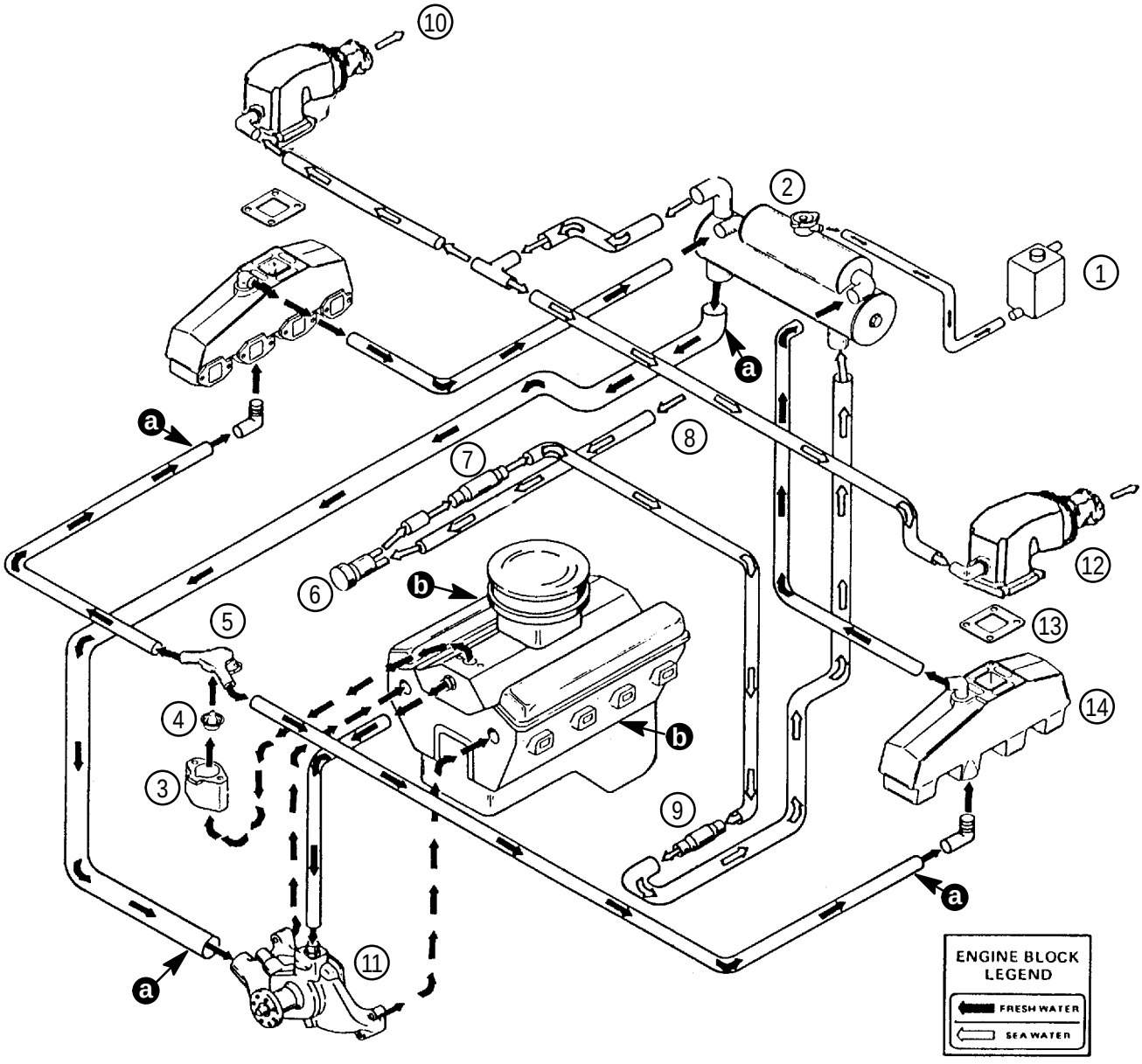
REAR MOUNTED CLOSED COOLING WITH COOLANT FLOW THRU EXHAUST MANIFOLDS



72985

a - Remove Hoses (Lift, Lower or Bend To Completely Drain).
b - Remove Block Plugs (Repeatedly Clean Out Holes Using A Stiff Wire Until Entire System Is Drained).

1 - Coolant Recovery Bottle
2 - Heat Exchanger
3 - Thermostat Housing
4 - Thermostat
5 - Thermostat Housing Cover
6 - Seawater Pickup Pump
7 - Transmission Cooler
8 - Seawater Inlet
9 - Oil Cooler
10- Overboard
11- Circulating Pump
12- Exhaust Elbow
13- Separator Gasket
14- Exhaust Manifold

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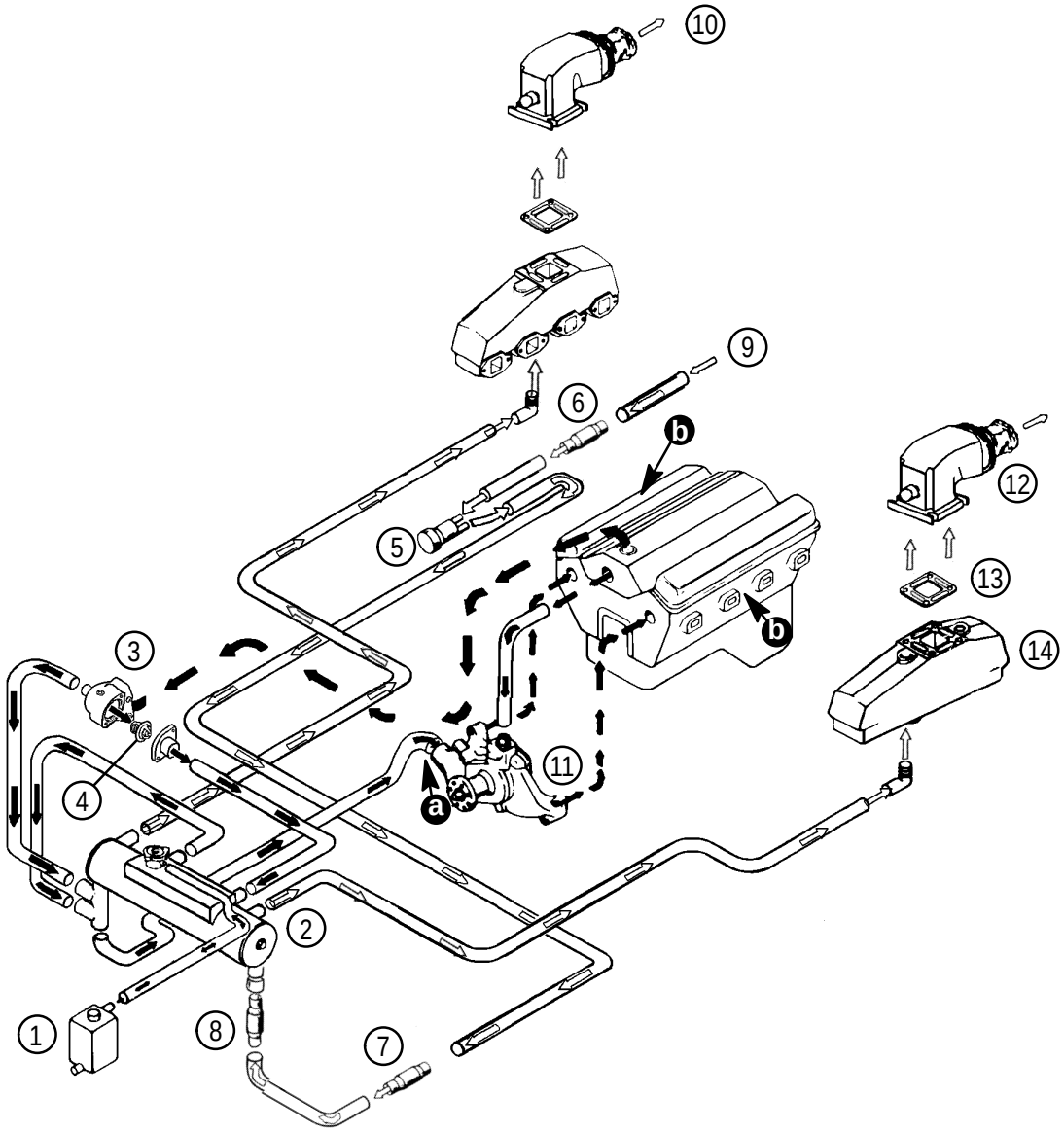
MIE 454 CID / 7.4L 502 CID / 8.2L WITH VERTICAL MOUNTED OIL COOLER / PORT SIDE MOUNTED TRANSMISSION COOLER / OPTIONAL FUEL COOLER AND MCM 454 CID / 7.4L WITHOUT COOLANT FLOW THROUGH EXHAUST MANIFOLDS



74745

a - Remove Hoses (Lift, Lower or Bend To Completely Drain).
b - Remove Block Plugs (Repeatedly Clean Out Holes Using A Stiff Wire Until Entire System Is Drained).

1 - Coolant Recovery Bottle
2 - Heat Exchanger
3 - Thermostat Housing
4 - Thermostat
5 - Seawater Pickup Pump
6 - Fuel Cooler
7 - Transmission Cooler
8 - Vertical Mounted Oil Cooler
9 - Seawater Inlet
10- Overboard
11- Circulating Pump
12- Exhaust Elbow
13- Separator Gasket
14- Exhaust Manifold

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Cleaning System

Closed Cooling Section

Closed cooling section of closed cooling system should be cleaned at least once every two years or whenever decreased cooling efficiency is experienced.

A good grade automotive cooling system cleaning solution may be used to remove rust, scale or other foreign material. Always follow manufacturer's instructions for the cleaner.

If closed cooling section is extremely dirty, a pressure flushing device may be used to flush out remaining deposits. Flushing should be done in direction opposite normal coolant flow to allow water to get behind deposits and force them out. Refer to instructions which accompany flushing device for proper hookup and flushing procedure.

NOTICE

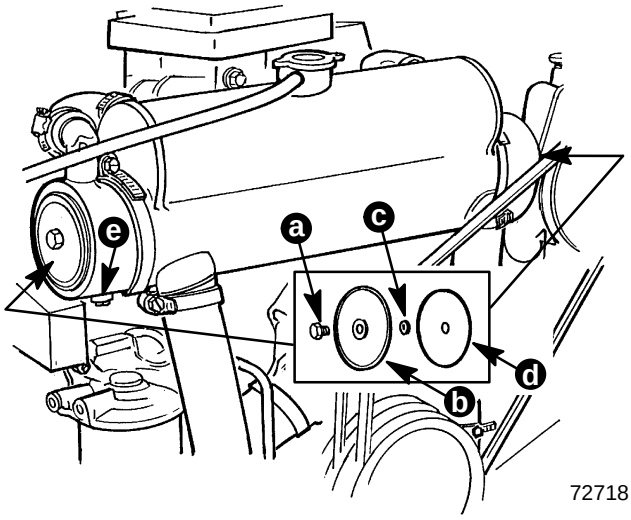
For information and procedures for draining and flushing Seawater Section of Closed Cooling (Coolant) Models, refer to SECTION 1B. For cold weather or extended storage, refer to SECTION 1B.

Seawater Section

Cooling efficiency of an engine with closed cooling is greatly dependent upon heat transfer through the tubes within the heat exchanger. During engine operation, contaminants within the seawater (such as salt, silt, lime, etc.) collect on the inside of the tubes, thus reducing heat transfer and greatly decreasing heat exchanger efficiency. It is, therefore, recommended that the seawater section of the heat exchanger be cleaned at least once every two years or whenever decreased cooling efficiency is suspected, as follows:

IMPORTANT: It may be necessary to remove heat exchanger on some models. If heat exchanger is removed, be sure to refill closed cooling section with coolant.

1. Remove seawater drain plug from bottom of heat exchanger and allow water to drain. After water has drained completely, coat threads of drain plug with Quicksilver Perfect Seal and reinstall.



72718

Typical V-8 Engine

a - Bolt
b - End Cap
c - Sealing Washer
d - Gasket
e - Drain Plug

2. Remove bolts which secure end plates to each end of heat exchanger, then remove end plates, seal washers and gaskets. Discard seal washers and gaskets. Clean gasket material from end plates and heat exchanger.
3. Clean water passages in heat exchanger by inserting a suitable size wire brush into each passage. Use compressed air to blow loose particles out of water passages.
4. Apply Quicksilver Perfect Seal to both sides of new end plate gaskets, then reinstall end plates, using new gaskets and seal washers. (Be sure to install seal washers between end plates and gaskets.) Torque end plate bolts to specifications.

⚠CAUTION

Avoid seawater pickup pump impeller damage. DO NOT operate engine without water being supplied to seawater pickup pump.

5. With boat in the water and/or cooling water properly supplied to seawater pickup pump, start engine and inspect for leaks.

Filling Closed Cooling Section

Fresh Water Flow Thru Exhaust Manifold

NOTICE

See "Specifications" for approximate closed cooling system capacity and coolant recommendation.

⚠WARNING

Do not remove coolant cap when engine is hot. Coolant may discharge violently.

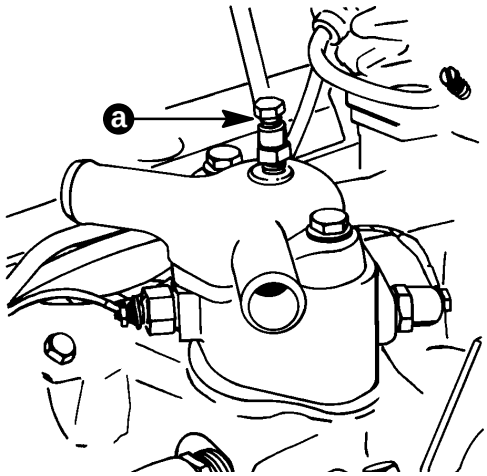
⚠CAUTION

Alcohol or Methanol based antifreeze or plain water are not recommended for use in fresh water section of cooling system at any time.

⚠CAUTION

Front of engine should be higher than rear to purge trapped air out of the system during initial filling. This will minimize the possibility of air being trapped in the closed cooling section which can cause engine to overheat.

1. Remove coolant cap on heat exchanger.



71518

a - Hex Head Bleeder

2. Open hex bleeder on thermostat.
3. Fill closed cooling system with coolant mixture through heat exchanger fill neck until coolant appears at bleeder valve.
4. Close bleeder securely.
5. Continue filling closed cooling section until coolant level is 1 in. (25 mm) below filler neck.

⚠CAUTION

Avoid seawater pickup pump impeller damage and subsequent overheating damage to stern drive unit. DO NOT operate engine without water being supplied to seawater pickup pump.

⚠CAUTION

Models with belt drive seawater pickup pump must be in the water when running engine because garden hose will not supply enough water to system at higher RPM.

6. With pressure cap off, start engine and run at fast idle (1500-1800 RPM). Add coolant solution to heat exchanger, as required, to maintain coolant level 1 in. (25 mm) below filler neck.
7. After engine has reached normal operating temperature (thermostat is fully open), and coolant level remains constant, fill heat exchanger to bottom of filler neck.
8. Observe engine temperature gauge to make sure that engine operating temperature is normal. If gauge indicates excessive temperature, stop engine immediately and examine for cause.
9. Install pressure cap on heat exchanger.
10. Remove cap from coolant recovery reservoir and fill to FULL mark with coolant solution. Reinstall cap.
11. With engine still running, check hose connection, fittings and gaskets for leaks. Repeat Step 4.

IMPORTANT: Engine overheating is often due to air being trapped in closed cooling section. Purge air by running engine at 2000 RPM for 10 minutes.

⚠WARNING

Allow engine to cool before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled, turn cap 1/4 turn to allow any pressure to escape slowly, then push down and turn cap all the way off.

12. Recheck coolant level after first open-throttle boat test and add coolant, if necessary.
13. Maintain coolant level in coolant recovery reservoir between ADD and FULL marks with engine at normal operating temperature.

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Seawater Flow Thru Exhaust Manifolds

⚠CAUTION

Alcohol or Methanol base antifreeze or plain water, are not recommended for use in coolant section of Closed Cooling System at any time.

It is recommended that coolant section of Closed Cooling System be filled with a 50/50 mixture of ethylene glycol antifreeze and pure, soft water. Antifreeze MUST BE used regardless of whether freezing temperatures are or are not expected to provide adequate corrosion protection. In areas where ethylene glycol antifreeze is not available and the possibility of freezing DOES NOT exist, it is permissible to use a solution of rust inhibitor and pure, soft water (mixed to manufacturer's recommendations).

NOTE: *Coolant section capacity is approximately 4 U.S. Gallons (15 L).*

1. Fill coolant section of Closed Cooling System with coolant mixture as follows:
   a. Open bleeder valve on thermostat housing.
   b. Fill with coolant mixture through heat exchanger fill neck until coolant appears at bleeder valve opening.
   c. Close bleeder valve securely.
   d. Continue filling until coolant level is into filler neck and begins to flow into coolant recovery bottle plastic tubing.

⚠CAUTION

DO NOT operate engine without water flowing thru seawater pickup pump, as pump impeller may be damaged and subsequent overheating damage to engine or stern drive unit may result.

- **Front of engine should be higher than rear to purge trapped air out of the system during initial filling. This will minimize the possibility of air being trapped in the closed cooling section which can cause engine to overheat.**

IMPORTANT: This closed cooling system flows coolant at a high rate. Higher idle speeds increase dispersion of trapped air into system making it more difficult to purge trapped air. Operate at idle during filling and air purging when specified.

2. Start engine and run AT IDLE. Add coolant solution to heat exchanger, as required, to maintain coolant level at filler neck. After engine has reached normal operating temperature (thermostat is fully open), and coolant level remains constant, fill heat exchanger until coolant level is into filler neck and begins to flow into coolant recovery bottle plastic tubing.
3. Remove cap from coolant recovery reservoir and fill to "Full" mark with coolant solution. Reinstall cap.
4. Lift recovery bottle and plastic tubing *above* heat exchanger filler neck. Allow coolant to flow down through tubing to purge air through filler neck fitting.
5. Install pressure cap on heat exchanger.
6. With engine still running, check hose connections, fittings and gaskets for leaks. Also observe engine temperature gauge to make sure that engine operating temperature is normal. If gauge indicates excessive temperature, stop engine immediately and examine for cause.

⚠WARNING

Allow engine to cool down before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled down, turn cap 1/4-turn to allow any pressure to escape slowly, then, push down and turn cap all-the-way off.

7. Recheck coolant level after first open-throttle boat test and add coolant, if necessary.
8. Maintain coolant level in coolant recovery reservoir between "Add" and "Full" marks with engine at normal operating temperature.

Coolant section of Closed Cooling System should be kept filled year around with recommended coolant solution. DO NOT drain coolant, fresh water section, for storage, as this will promote rusting of internal surfaces. If engine will be exposed to freezing temperatures, make sure that coolant section is filled with ethylene glycol antifreeze and water solution, mixed to manufacturer's recommended proportion, to protect engine to lowest temperature to which it will be exposed.

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Auxiliary Hot Water Heater Installation

IMPORTANT: When connecting a cabin heater or hot water heater, certain requirements must be met.

- **Supply hose (from engine to heater) and return hose (from heater to engine) MUST NOT EXCEED 5/8 in. (15.8 mm) I.D. (inside diameter).**
- **Engine with a Closed Cooling System: Heater MUST BE LOWER than fill cap on the heat exchanger. If the heater is higher than the fill cap on the heat exchanger and some coolant is lost in the system, an air pocket may form in the closed cooling system. This, in turn, can cause the engine to overheat.**
- **Make heater connections ONLY at locations described in the following instructions.**
- **Check complete system for leaks after heater is connected into cooling system.**
- **Check for overheating condition (of engine) after heater is connected.**

1. Refer to “Changing Coolant - Draining Instructions”; drain closed cooling system.
2. Inspect for appropriate location of supply hose at following:

⚠CAUTION

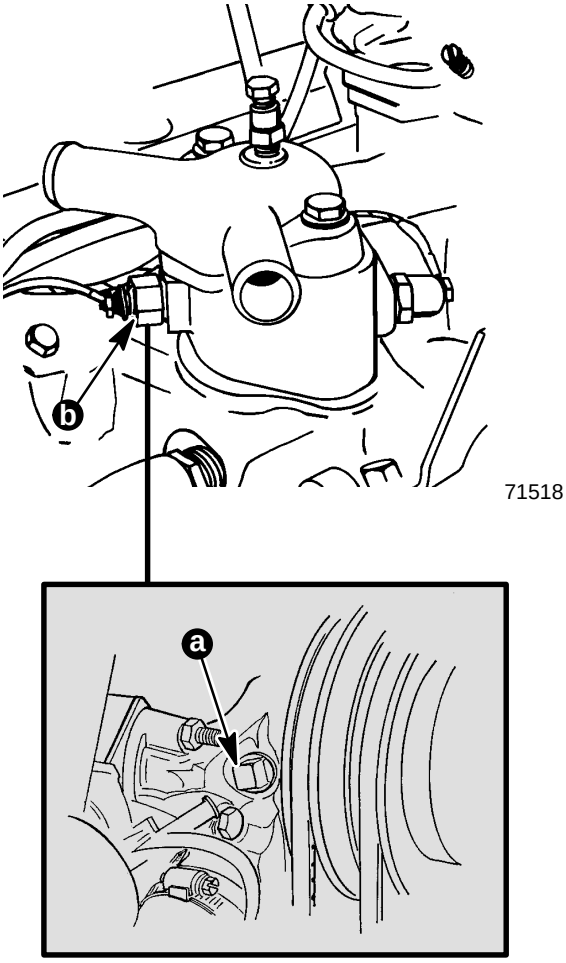
Avoid a performance loss and/or possible engine damage. Engine coolant must flow continuously from the engine intake manifold to the engine water circulating pump. NEVER close-off or block the coolant flow to or from a heater.
All heater installations must be plumbed in series with the supply and return connections.

NOTE: *Hot water heater supply hose can be connected at several different locations. On some models, there may be other accessories and options that are utilizing these hot water supply locations. One of the following should be available for use when installing a hot water heater system.*

NOTE: *On some models it may be necessary to remove the audio warning heat switch from port side of thermostat housing and reposition to water circulating pump opening as outlined following.*

IMPORTANT: Do not reposition engine temperature switch; it must remain where installed by factory.

Recommended Supply Locations



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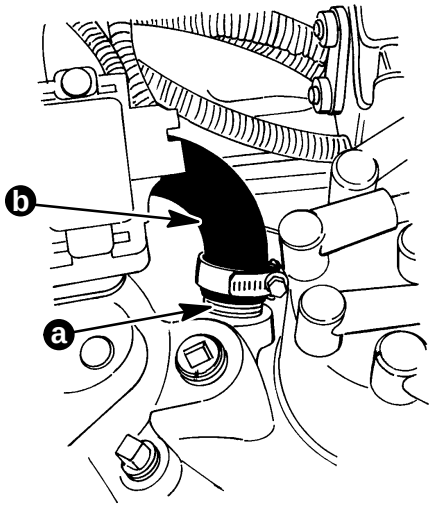
Thermostat Housing With Two Hose Connection

a - Audio Warning Switch Relocation
b - Water Supply Location



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MIE 7.4L / MCM 7.4LX Throttle Body Injection

a - Location For Hot Water Supply
b - Factory Hose

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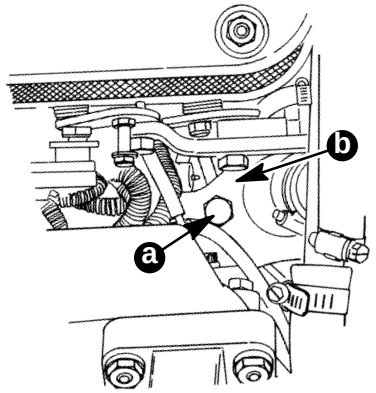

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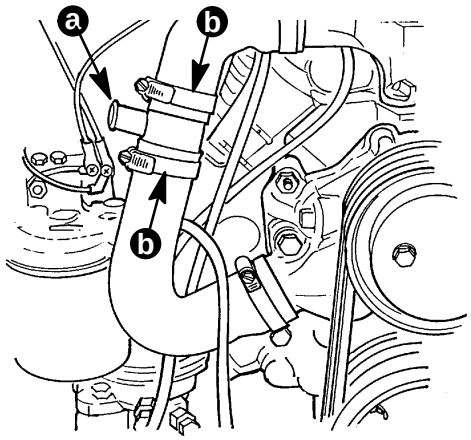
Multi-Port Injection Models Models Seawater Flow Through Exhaust Manifolds

a - Location for Hot Water Supply (Bayonet Fitting Replaces Brass Plug)
b - Thermostat Housing

Recommended Return Locations



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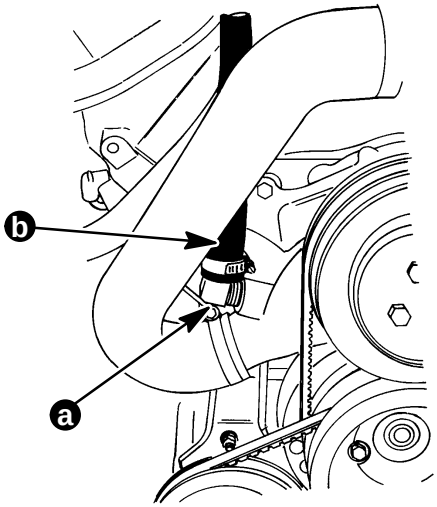
Thermostat Housing With Two Hose Connection

a - T-Fitting
b - Hose Clamps



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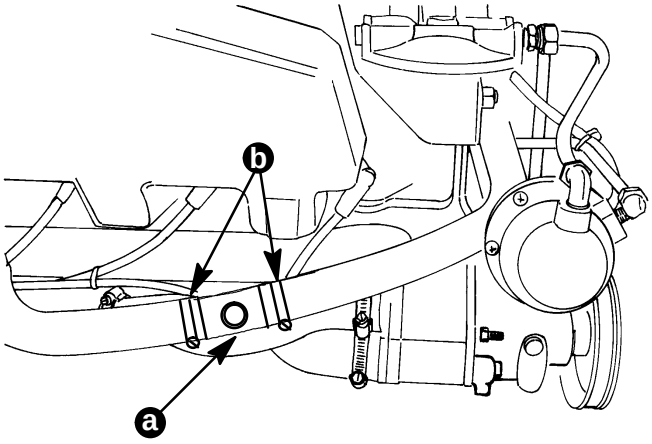
MIE 7.4L / MCM 7.4LX Throttle Body Injection

a - Location For Hot Water Return
b - Factory Hose



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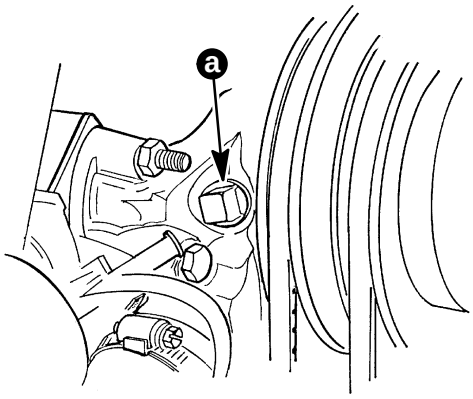
MIE Rear Mounted Closed Cooling (Starboard View)

a - T-Fitting
b - Hose Clamps



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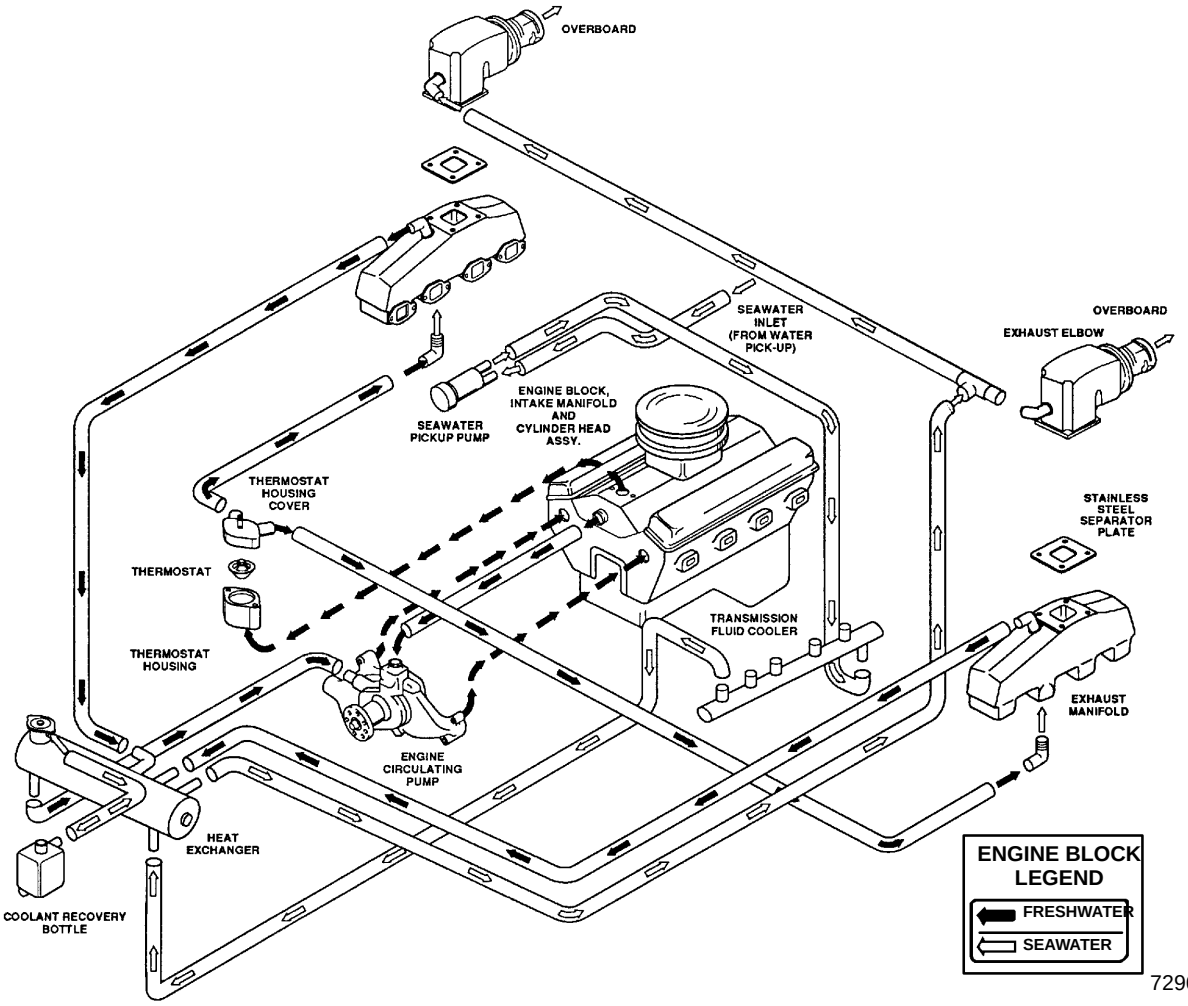
Multi-Port Injection Models Model[illegible]ater Flow Through Exhaust Manifolds

Closed Cooling System Flow Diagrams

MCM Bravo Models - 7.4L/454 Magnum



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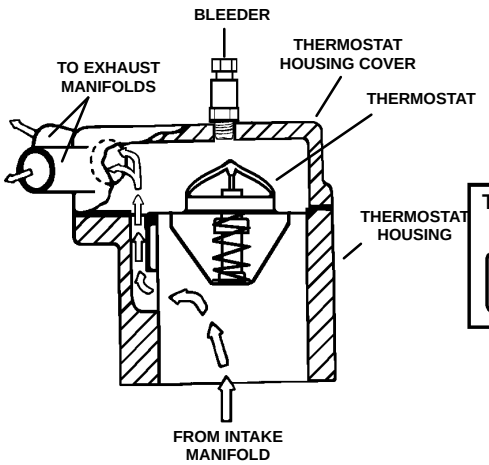
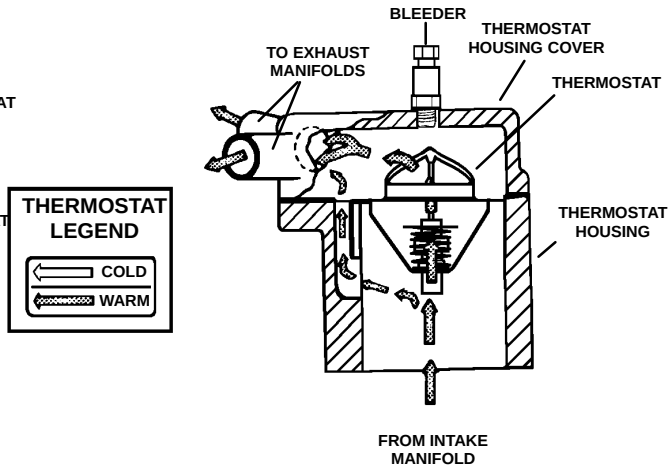


COOLANT FLOW THROUGH THERMOSTAT HOUSING WITH THERMOSTAT CLOSED (ENGINE COLD)



COOLANT FLOW THROUGH THERMOSTAT HOUSING WITH THERMOSTAT OPEN (ENGINE WARM)

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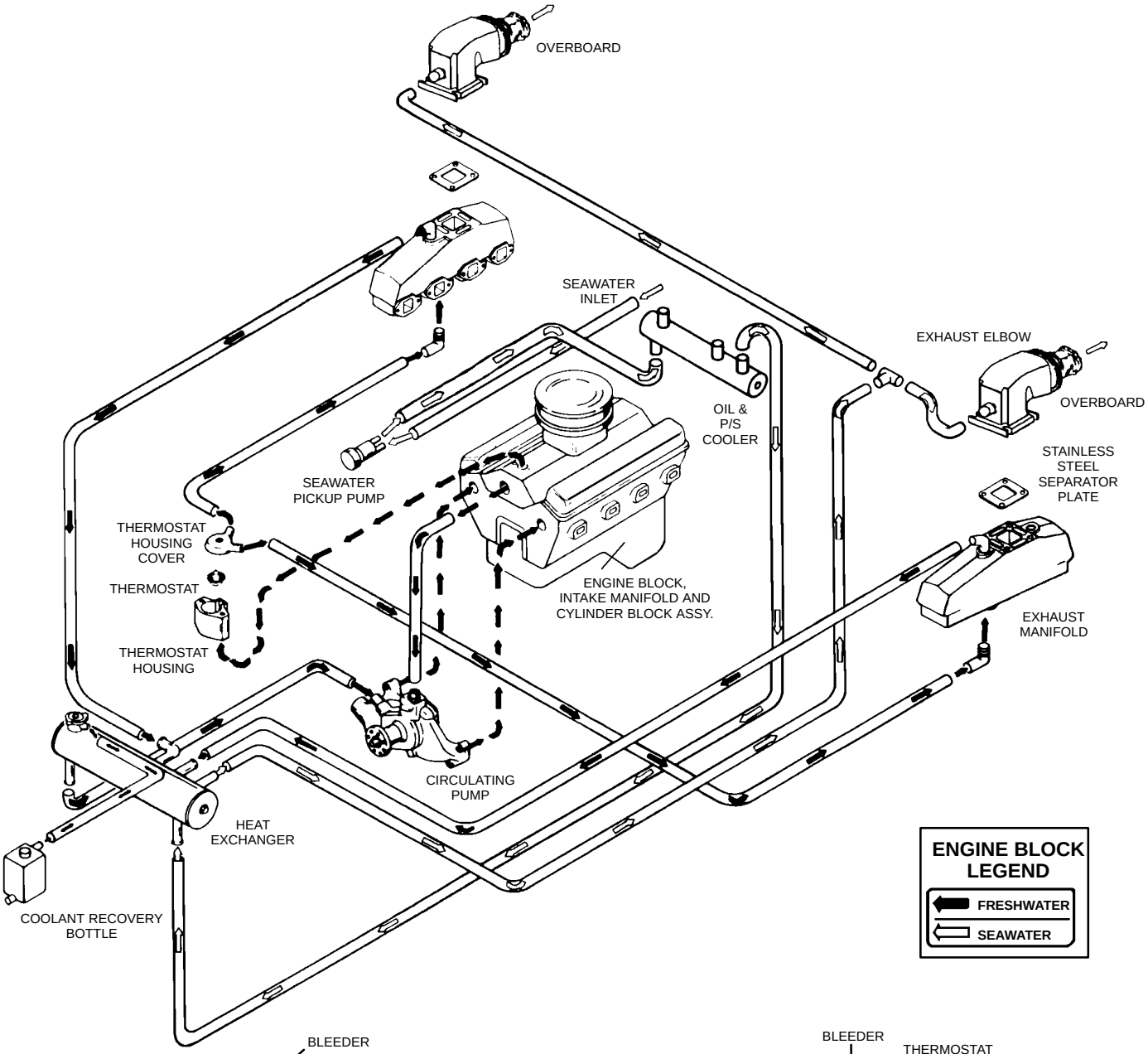
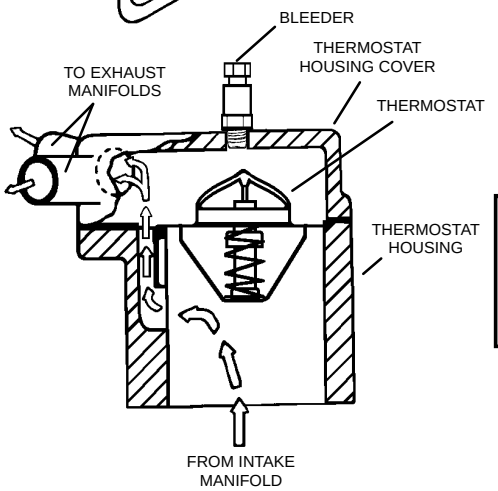
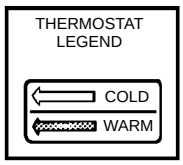
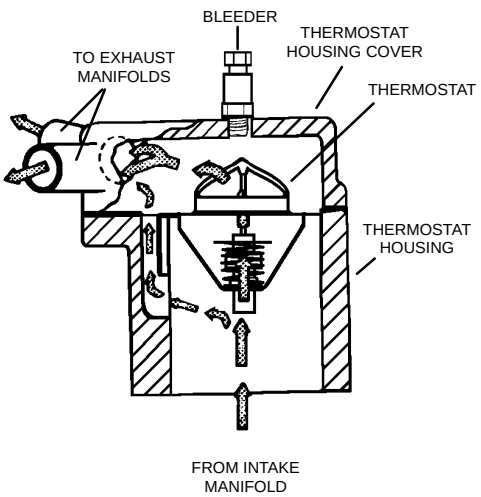
MCM Model - 502 Magnum





COOLANT FLOW THROUGH THERMOSTAT HOUSING WITH THERMOSTAT CLOSED (ENGINE COLD)





COOLANT FLOW THROUGH THERMOSTAT HOUSING WITH THERMOSTAT OPEN (ENGINE WARM)

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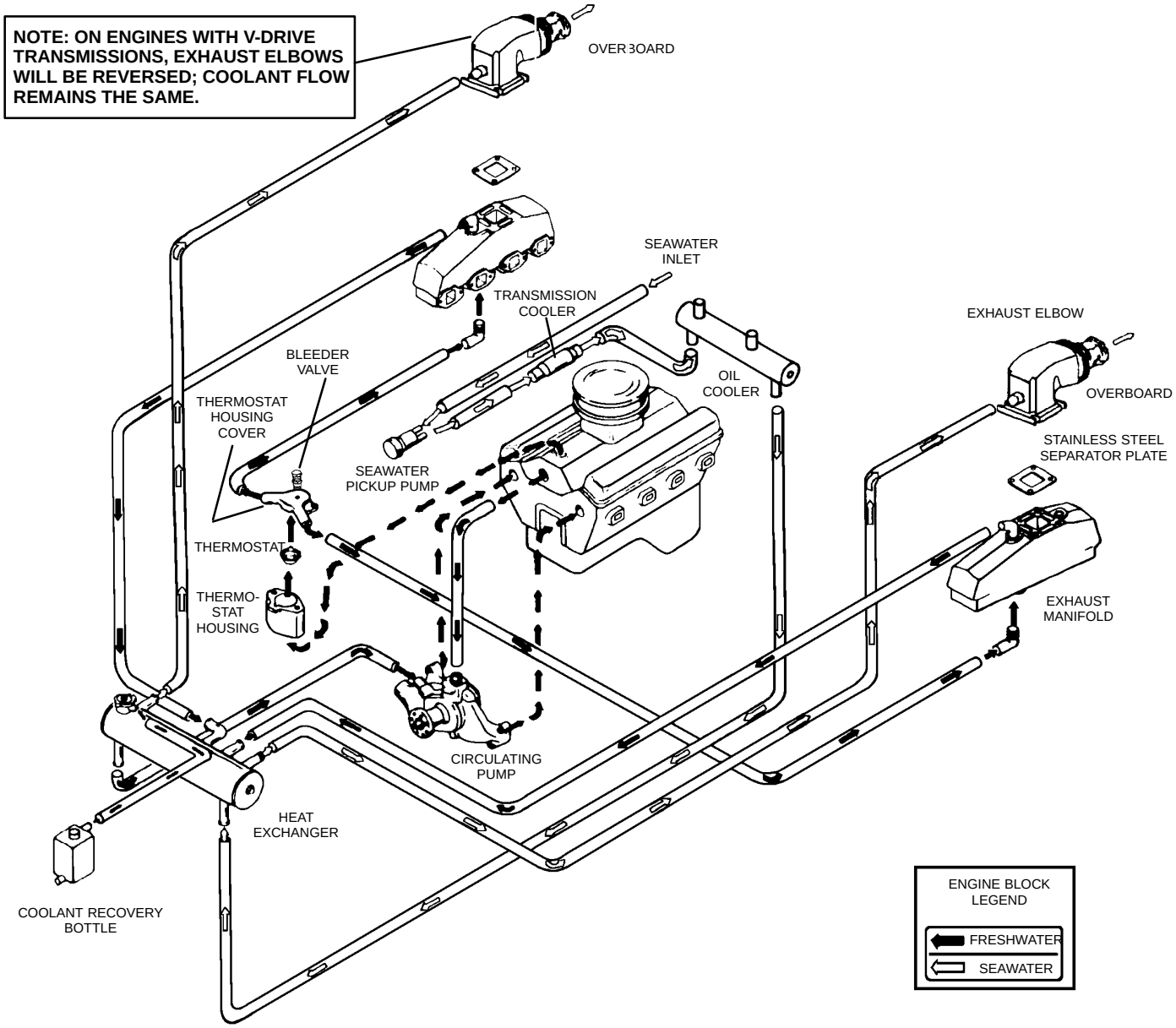
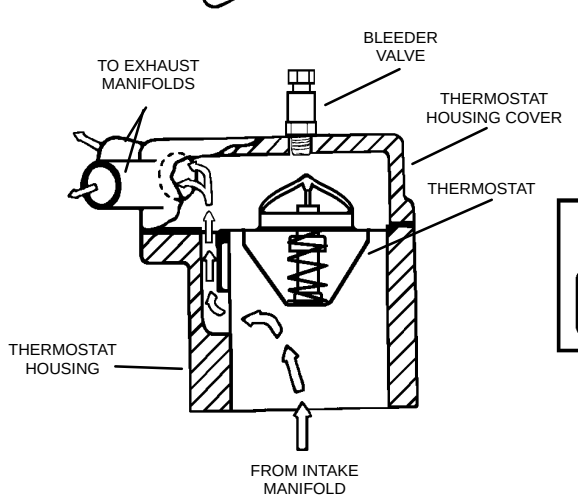
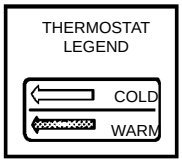
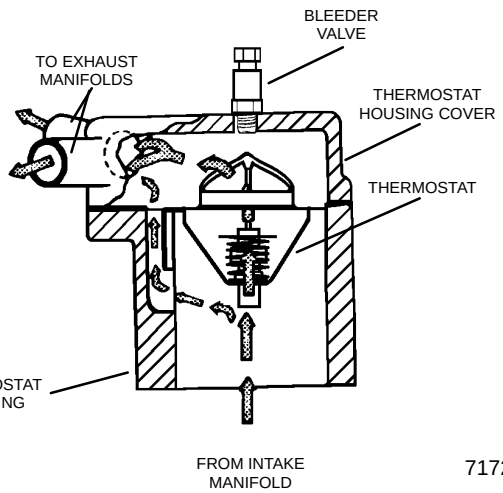
MIE Models - 7.4L / 8.2L





COOLANT FLOW THROUGH THERMOSTAT HOUSING WITH THERMOSTAT CLOSED (ENGINE COLD)





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COOLANT FLOW THROUGH THERMOSTAT HOUSING WITH THERMOSTAT OPEN (ENGINE WARM)

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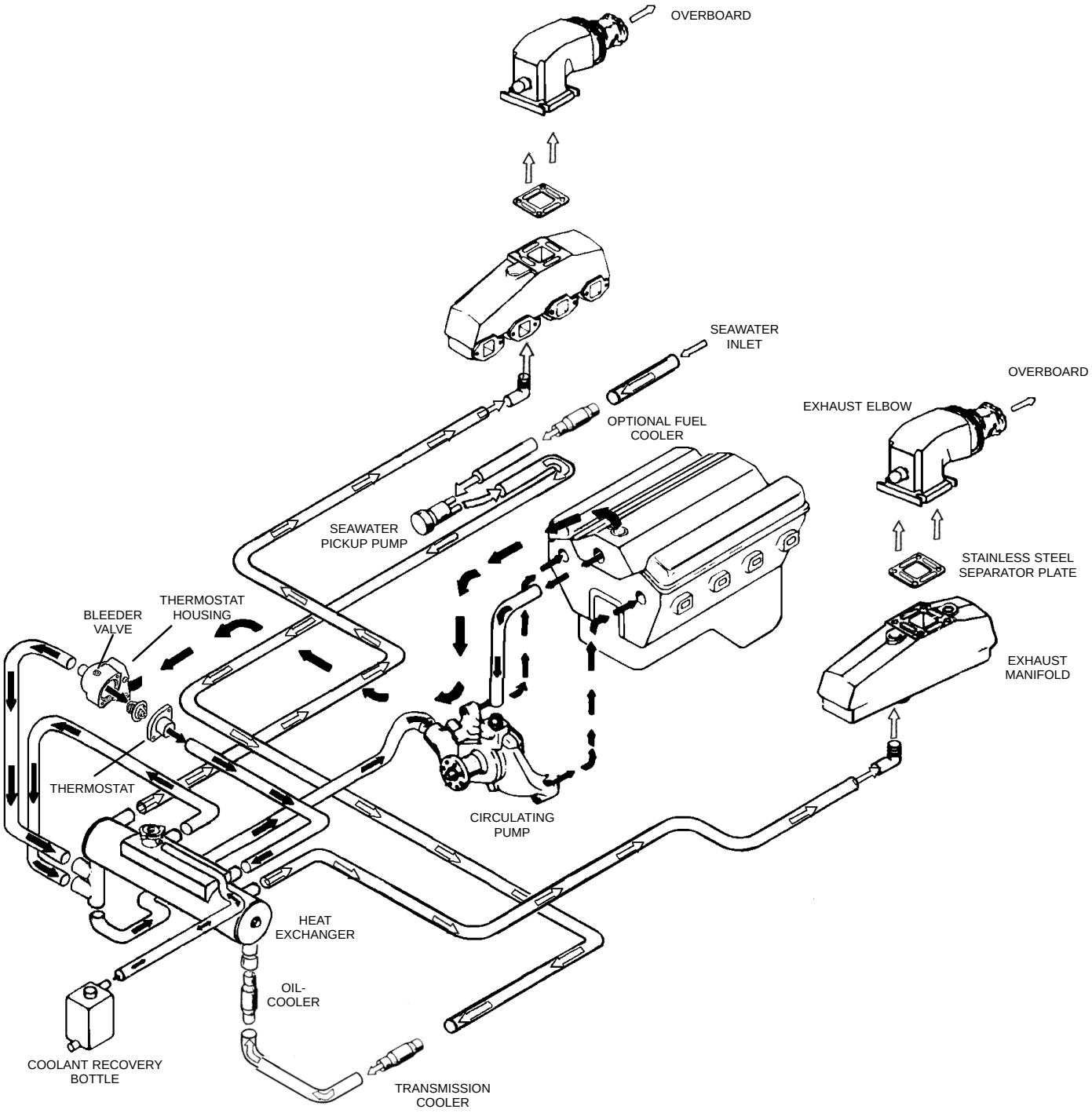
MIE 454 CID / 7.4L 502 CID / 8.2L with Vertical Mounted Oil Cooler / Port Side Mounted Transmission Cooler / Optional Fuel Cooler And MCM 454 CID / 7.4L Without Coolant Flow Through Exhaust Manifolds



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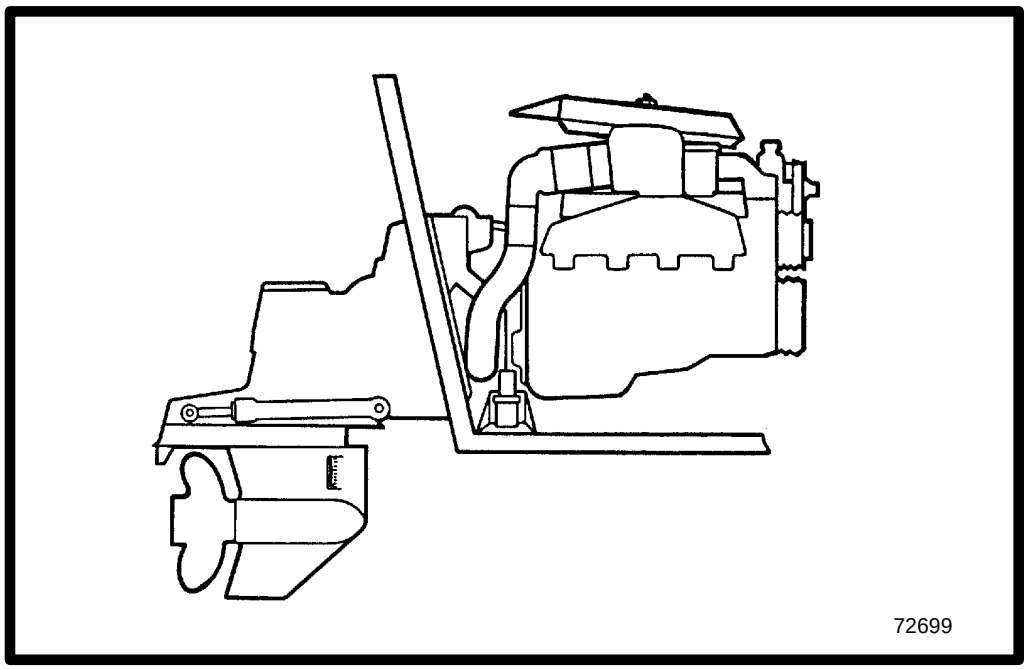
EXHAUST SYSTEM



7
A

GENERAL

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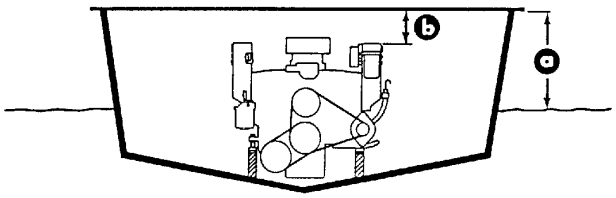
MIE (Inboard) Engines	7A-2
Exhaust Hose Connection	7A-2
Exhaust Tube Requirements	7A-3

Exhaust System Requirements

IMPORTANT: It is the responsibility of the boat manufacturer or installing dealer to properly locate the engine and install the exhaust system. Improper installation may allow water to enter the exhaust manifolds and combustion chambers and severely damage the engine. Damage caused by water in the engine will not be covered by MerCruiser Limited Warranty, unless this damage is the result of defective part(s).

Determining If Exhaust Elbow Risers Are Required

On all engines to determine if exhaust elbow risers are required, take measurements (a) and (b), with boat at rest in the water and maximum load aboard. Subtract (b) from (a). If (a) minus (b) is less than specified in chart, select appropriate size exhaust elbow riser kit and exhaust extension kit that will correctly position exhaust elbow.



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Exhaust Elbow Measurement

a - From Waterline To Top Of Transom
b - From Highest Point On Exhaust Elbow To Top Of Transom

Model	(a) Minus (b) Must Be at Least
All	13 In. (330 mm)

MCM (Stern Drive) Engines With Thru Transom Exhaust

When designing and installing exhaust system, the following must be observed:

Minimum Hose Size		
Model	**Single Outlet**	**Dual Outlet**
All (Except Magnums)	5 in. (127 mm)	4 in. (102 mm)
Magnum	–	4 in. (102 mm)

1. Exhaust flanges must be of proper size to accommodate 4 in. (102 mm) I.D. exhaust hoses. They must also be equipped with internal water shutters, and use an exhaust flapper over each outlet.
2. The exhaust hoses and pipes must not be higher than exhaust elbows at any point.
3. The exhaust outlet must be located so that a minimum of 1/2 in. (13 mm) drop per foot (305 mm) downward pitch exists in the exhaust hose from the engine exhaust elbow to the outlet. (This is an American Boat & Yacht Council recommendation.) The drop must be constant so that a low spot does not exist at any point in the exhaust hose.
4. Exhaust outlet must be slightly above the waterline with boat at rest in the water and full load aboard.
5. Back pressure must not exceed 4 in. (102 mm) of mercury when measured with a mercury manometer to exhaust elbow outlets.

MIE (Inboard) Engines

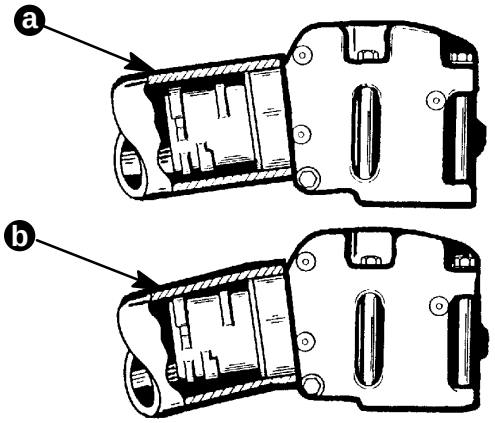
When designing and installing exhaust system, it is very important that the following additional points be taken into consideration:

1. System layout and construction must prevent cooling system discharge water from flowing back into engine and also must prevent seawater from entering engine via exhaust at any point.
2. The exhaust hoses and pipes must not be higher than exhaust elbows at any point.
3. The exhaust outlet (for routing exhaust to outside of boat) must be located so that a minimum of 1/2 in. (13 mm) per foot (305 mm) downward pitch (drop) exists in the exhaust hose or pipe from the engine exhaust elbow to the outlet, with a minimum drop of 4 in. (102 mm) overall. (This is an American Boat & Yacht Council recommendation.) The drop must be constant so that a low spot does not exist at any point in the exhaust hose or pipe.
4. Exhaust outlet must be slightly above the waterline with boat at rest in the water and full load aboard. Exhaust outlet should be equipped with an internal shutter to prevent seawater from running back into exhaust system. The use of an exhaust flapper on each outlet also is recommended.
5. System must not cause excessive back pressure. Back pressure MUST NOT exceed 4 in. (102 mm) of mercury when measured with a mercury manometer at exhaust elbow outlets. Minimum exhaust hose sizes are given in chart.

Minimum Hose Size		
Model	**Single Outlet**	**Dual Outlet**
All (Except Magnums)	5 in. (127 mm)	4 in. (102 mm)

Exhaust Hose Connection

1. Exhaust hoses must be connected to exhaust elbows so that they do not restrict the flow of discharge water from the elbow. If hoses are connected incorrectly, a hot spot in the hose can occur, and can eventually burn through.



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a - Correct Connection
b - Incorrect Connection

2. Exhaust hoses must be secured at each connection with two hose clamps.

Exhaust Tube Requirements

IMPORTANT: When installing thru-transom exhaust, it is recommended that the exhaust bellows on the transom assembly be removed. This is necessary to avoid creating a vacuum at the exhaust outlet in the propeller at higher boat speeds. This vacuum could degrade propeller performance on some boats.

IMPORTANT: When installing thru-propeller exhaust:

- **With any application, installation of an exhaust tube will increase exhaust noise.**
- **With Bravo One and Bravo Two Drives an exhaust tube MAY BE INSTALLED for a slight increase in performance.**
- **With a Silent Choice Exhaust System the exhaust bellows must be removed and an exhaust tube MUST BE INSTALLED.**
- **With most Bravo Three Drive Models an exhaust tube MAY BE INSTALLED for a slight increase in performance. On the following Bravo Three Models, the exhaust bellows must be removed and an exhaust tube MUST BE INSTALLED:**
  - **MCM 7.4LX EFI**
  - **MCM 7.4LX MPI**
  - **MCM 454 Magnum**
  - **MCM 454 Magnum MPI**
  - **MCM 502 Magnum MPI**

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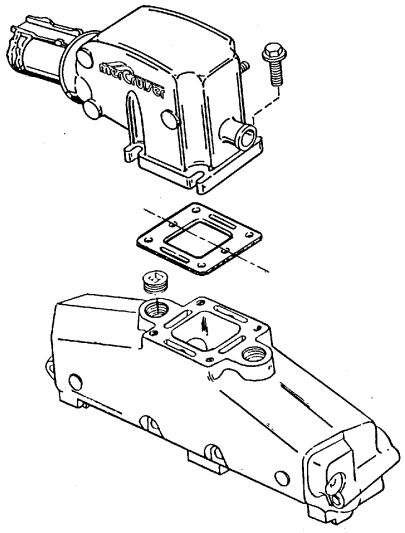
EXHAUST SYSTEM



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B

MANIFOLDS AND ELBOWS

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Cleaning and Inspection	7B-2
Installation	7B-2

Torque Specifications

Fastener Location	Lb. Ft.	N·m
Hose Clamp	Securely	
Exhaust Elbow	25	34
Exhaust Manifold		

Sealants

Description	Part Number
Quicksilver Perfect Seal	92-34227-1

Removal

⚠ WARNING

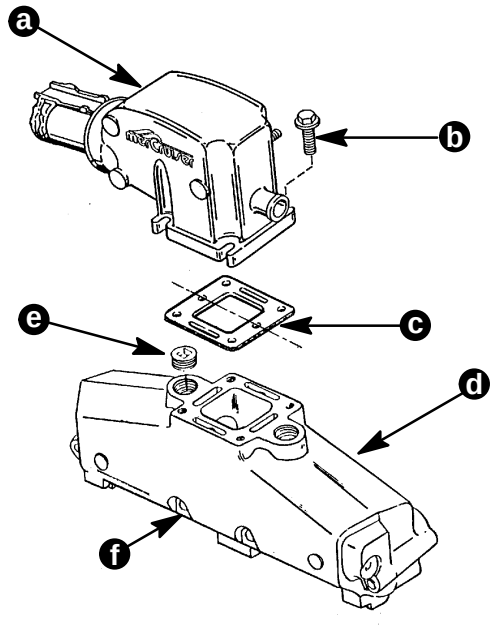
Avoid possible injury or damage to equipment should wires be accidentally shorted. Disconnect BOTH battery cables from battery before proceeding.

1. Disconnect battery cables from battery.

⚠ CAUTION

To avoid severe engine damage. Exhaust elbows and manifolds MUST BE drained to prevent water (or coolant) from entering combustion chambers when exhaust elbows are removed.

2. Drain water from manifold and exhaust elbow. (Refer to SECTION 6A or 6B.)
3. Disconnect exhaust bellows and cooling hoses.
4. **Starboard Manifold:**
   a. Disconnect both shift cables (MCM only).
   b. Disconnect instrument harness plug from engine harness, if mounted on exhaust elbow.
   c. Remove shift plate assembly from exhaust elbow (MCM only).
   d. Remove bolt holding bracket for Quicksilver Water Separating Fuel Filter to exhaust manifold.
5. **Port Manifold:**
   a. Remove remote oil filter and bracket.
   b. Remove ignition module from exhaust elbow (if so equipped)
6. Remove exhaust elbow.
7. Remove exhaust manifold fasteners; remove manifold assembly and discard gaskets.



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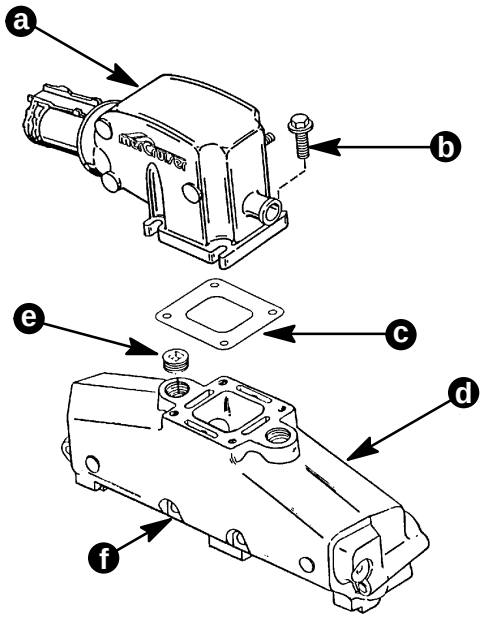
Stainless Steel Elbow With Restrictor Gasket

a - Exhaust Elbow
b - Bolts (4)
c - Gasket-Seawater Cooled (Aligned As Shown)
d - Exhaust Manifold Assembly
e - Plug



72696

Stainless Steel Elbow With Separator Gasket

a - Exhaust Elbow
b - Bolts (4)
c - Manifold Separator Gasket
d - Exhaust Manifold Assembly
e - Plug

Index

Cleaning and Inspection

1. Clean gasket material from all surfaces and wash parts in solvent.
2. Inspect all parts carefully. Machined surfaces must be clean and free of all marks and deep scratches, or water and exhaust leaks may result.
3. Check water passages for foreign material. Passages must be clean for efficient cooling.
4. If more thorough inspection is desired, pipe plugs may be removed from exhaust manifold and exhaust elbow.

IMPORTANT: If plugs are removed, coat threads with Quicksilver Perfect Seal before reinstalling.

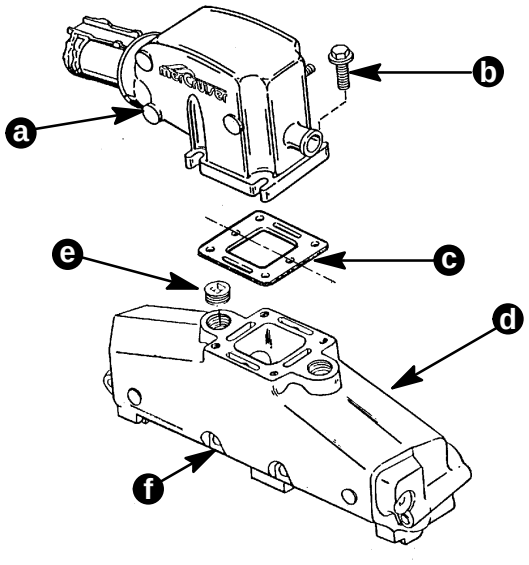
5. Check for cracks.
6. To test manifold body for leaks, block-off plates, plugs, or short hoses with plugged ends must be used. One block-off plate must have a threaded hole for attaching compressed air hose. Use new gaskets when installing block-off plate(s). Apply 40 PSI (276 kPa) of air pressure and submerge manifold in water. Air bubbles will indicate a leak.

Installation

1. Using new gasket, install exhaust manifold to cylinder head. Torque fasteners to 25 lb. ft. (34 N·m).

IMPORTANT: See Section 7C if exhaust risers are used.

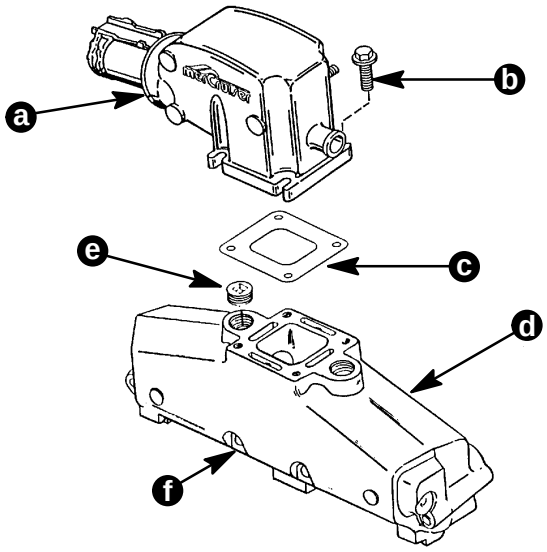
2. Using a new gasket, install exhaust elbow to exhaust manifold. Torque fasteners to 25 lb. ft. (34 N·m).
3. **Port Manifold:**
   a. Install remote oil filter and bracket.
   b. Install ignition module on exhaust elbow (if so equipped)
4. **Starboard Manifold:**
   a. Install bolt to secure Quicksilver Water Separating Fuel Filter bracket to exhaust manifold.
   b. Install shift plate assembly on exhaust elbow (MCM only).
   c. Connect instrument harness plug to engine harness, if disconnected previously.
   d. Connect both shift cables (MCM only).
5. Install exhaust elbows and cooling hoses.
6. **On Closed Cooled Models:** Refill closed cooling system to operating level with properly mixed coolant. Refer to SECTION 6B.
7. Reconnect battery cables to battery. Tighten securely.
8. Start engine and check for fuel, exhaust and water leaks.



72695

Stainless Steel Elbow With Restrictor Gasket (Cast Iron Elbow Similar)

a - Exhaust Elbow
b - Bolts (4)
c - Gasket - Seawater Cooled (Aligned As Shown)
d - Exhaust Manifold
e - Plug



72696

Stainless Steel Elbow With Separator Gasket (Cast Iron Elbow Similar)

a - Exhaust Elbow
b - Bolts (4)
c - Gasket - Seawater Cooled (Aligned As Shown)
d - Exhaust Manifold
e - Plug
f - Bolts (4)

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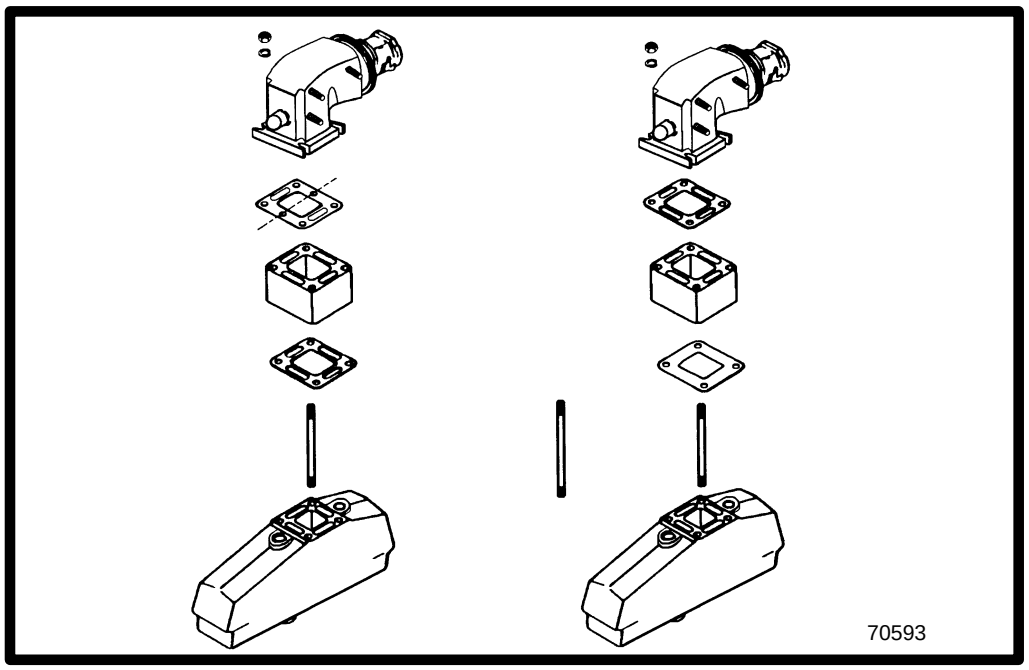
EXHAUST SYSTEM



7

C

RISERS

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Exhaust Riser (Kit) Identification

IMPORTANT: All listed MCM and MIE Models can be adapted to 9 inch (228 mm) exhaust risers by stacking 3 inch (76 mm) riser kit (93320A7) and the 6 inch (152 mm) riser kit (9322A4) with stainless steel elbows.

Torque Specifications

Fastener Location	Lb. Ft.	N·m
Exhaust Elbow	27	37
Exhaust Riser		

Sealants

Description	Part Number
Quicksilver Perfect Seal	92-34227-1

Replacement Information

Engine Preparation and Parts Removal

⚠ WARNING

Avoid possible injury or damage to equipment should wires be accidentally shorted. Disconnect BOTH battery cables from battery before proceeding.

1. Disconnect battery cables from battery.

⚠ CAUTION

Avoid severe engine damage. Exhaust elbows and manifolds MUST BE drained to prevent water (or coolant) from entering combustion chambers when exhaust elbows are removed.

2. Drain exhaust elbows and exhaust manifolds.
3. Remove any items attached to the elbows on the engine and carefully lay them aside. Remember their positioning for reassembly later.
4. Remove fasteners retaining exhaust elbows and risers to manifolds and retain. Remove exhaust elbows.
5. Remove and discard old gaskets. Clean gasket mating surfaces on elbows, manifolds and risers.

Engine Preparation and Component Removal

1. Assemble studs to exhaust manifold and position all gaskets as shown between risers. Refer to "Installation Diagrams" at the end of this section.

IMPORTANT: Restrictor gaskets or manifold separator gaskets must be installed in order shown.

⚠CAUTION

If engine is equipped with closed cooling, MANIFOLD SEPARATOR GASKET MUST BE INSTALLED ONLY ON EXHAUST MANIFOLD. Failure to install separator gaskets on exhaust manifolds, or to install in a location other than shown, will result in severe engine damage.

2. Install elbow on riser(s) and studs. Attach using nuts and washers.

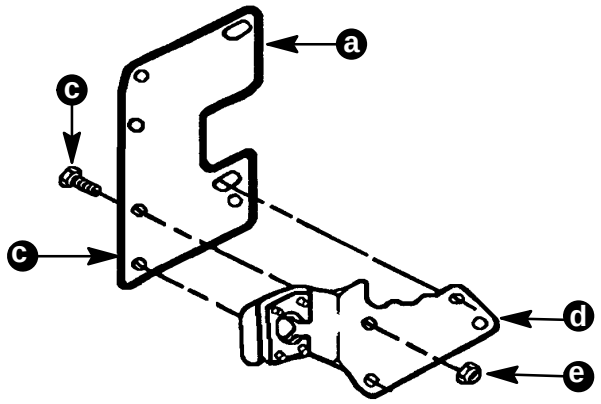
NOTE: *Drain plugs in risers must be positioned facing flywheel end of engine, unless otherwise noted.*

3. Torque all fasteners, in a diagonal pattern, to 27 lb.ft. (37 N·m).
4. Place spacers between riser plate, if so equipped, and fasten with existing nuts. Tighten securely.
5. Reattach and tighten securely all parts previously removed from elbow to appropriate position on riser bracket, if so equipped.

IMPORTANT: On elbows with ignition amplifier, be sure to reconnect amplifier and wiring harness ground wires to one of the attaching screws and that amplifier spacers are installed between amplifier and exhaust elbow. Tighten screws securely.

IMPORTANT: On elbows with shift plate (MCM only) reinstall shift plate and tighten fasteners securely, then readjust shift cables as outlined in appropriate Stern Drive Service Manual.

6. Assemble harness bracket and plastic backup plate, if so equipped, using four small screws.



70244

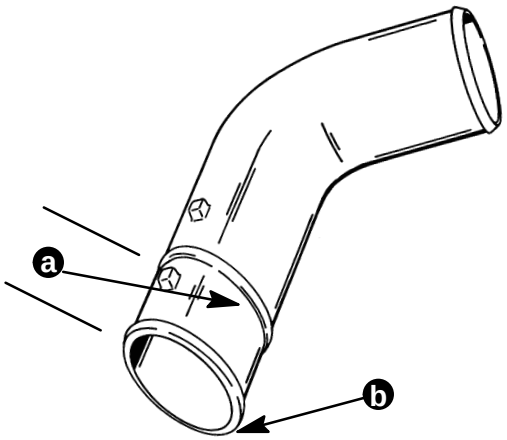
Bracket For 6 Inch (152 mm) Riser

a - Riser Bracket
b - Harness Plate
c - Back-Up Plate (1) - Screws (4) 7/8 In. (22 mm)
d - Screws (6) 3/4 In. (19 mm)
e - Nuts (6)

7. Refill closed cooling system, if so equipped. (Refer to SECTION 6B - "Closed Cooled Models.")
8. Upon first start-up of engine check for leaks.

Exhaust Extension Kit Installation

1. Install appropriate exhaust extension (see “Additional Kits”) for MCM Models with thru prop exhaust, using two hose clamps at each end.



50930

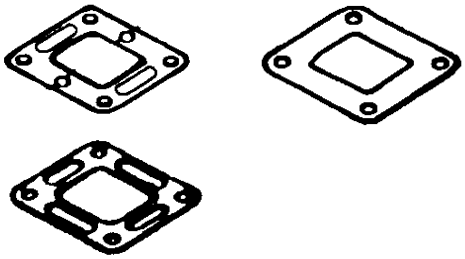
a - Cut Along Bottom Edge Of Welt For With 3in. (76 mm) Riser
b - Leave Full Length For Use With 6 In. (152 mm) Riser

Typical Exhaust Extension (See “Additional Kits” at Front of Section for Kit Part Number)

2. Tighten hose clamps securely.
3. Upon first start-up of engine check for leaks.

Installation Diagrams

IMPORTANT: Remember what type of gasket (open, restrictor or separator) is on exhaust manifold after removing the exhaust elbow.



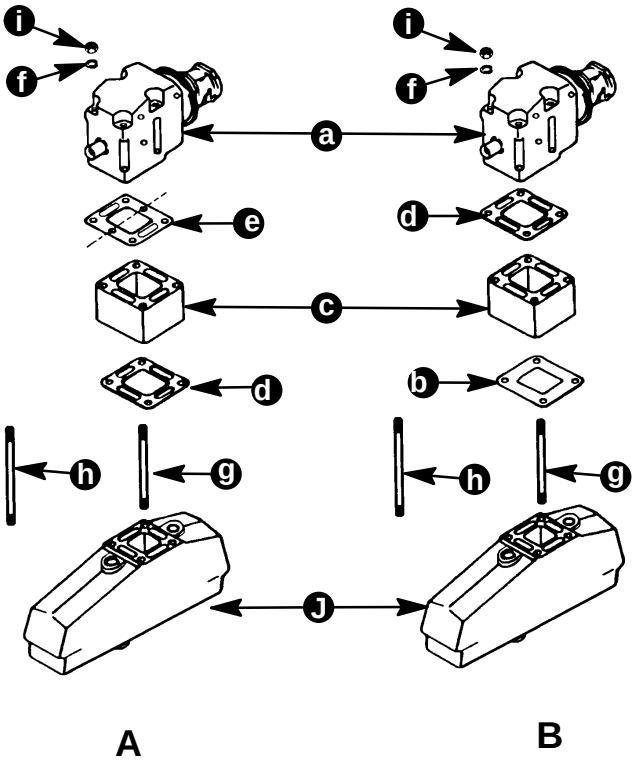
70622

A **B**

a - Restrictor and Open Gasket
b - Separator Gasket

1. Position gaskets (REFER TO EXPLODED VIEWS “**A**” OR “**B**” ON FOLLOWING PAGES), install elbows to risers and attach using nuts and washers from kit. Torque to 23-32 Ft. Lb. (32-43 N·m).

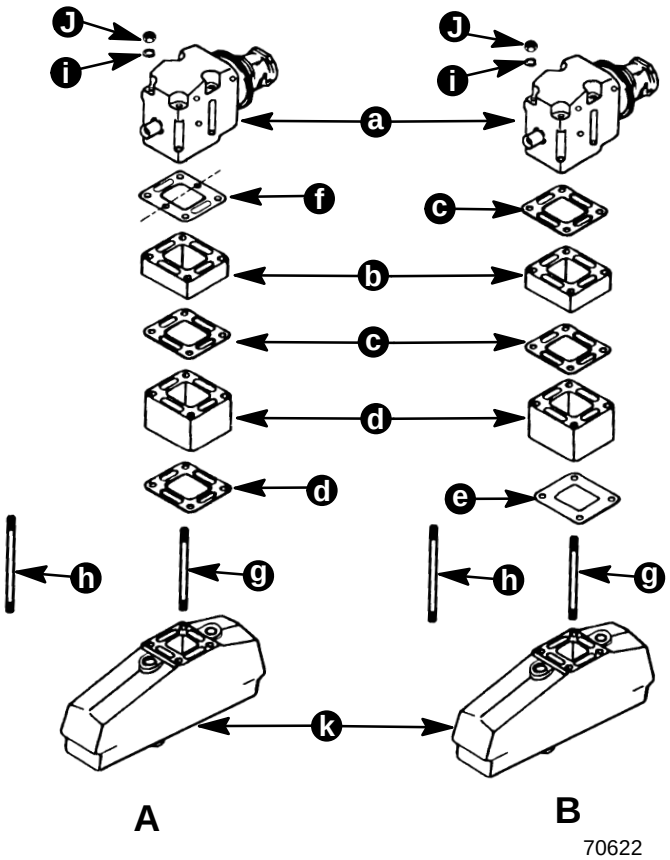
Cast Iron Elbows



70621

a - Exhaust Elbow
b - Separator Gasket
c - 3 Inch (76 mm) Exhaust Riser
d - Open Gasket
e - Restrictor Gasket
f - Nut (8)
g - Stud (8) 9-3/8 Inch (238 mm)
h - Stud (8) 10-3/8 Inch (264 mm) Used With Remote Oil Filter
i - Washer (8)
j - Exhaust Manifold

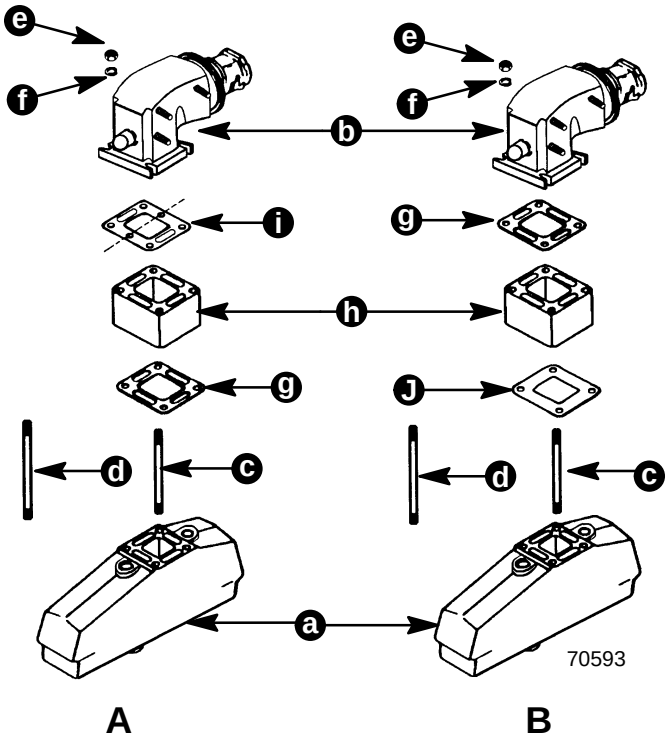
Cast Iron Elbows With Mufflers



70622

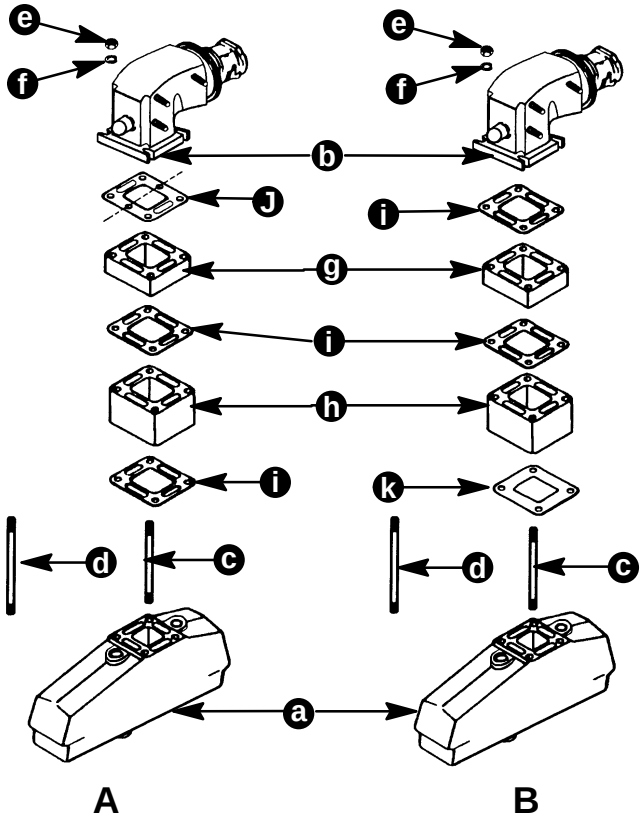
a - Exhaust Elbow
b - Muffler Spacer 1-1/4 Inch (32 mm)
c - Open Gasket
d - Exhaust Riser 3 Inch (76 mm)
e - Separator Gasket
f - Restrictor Gasket
g - Nut (8)
h - Stud (8) 9-3/8 Inch (238 mm)
i - Stud (8) 10-3/8 Inch (264 mm) Used With Remote Oil Filter
j - Washer (8)
k - Exhaust Manifold

Stainless Steel Elbows



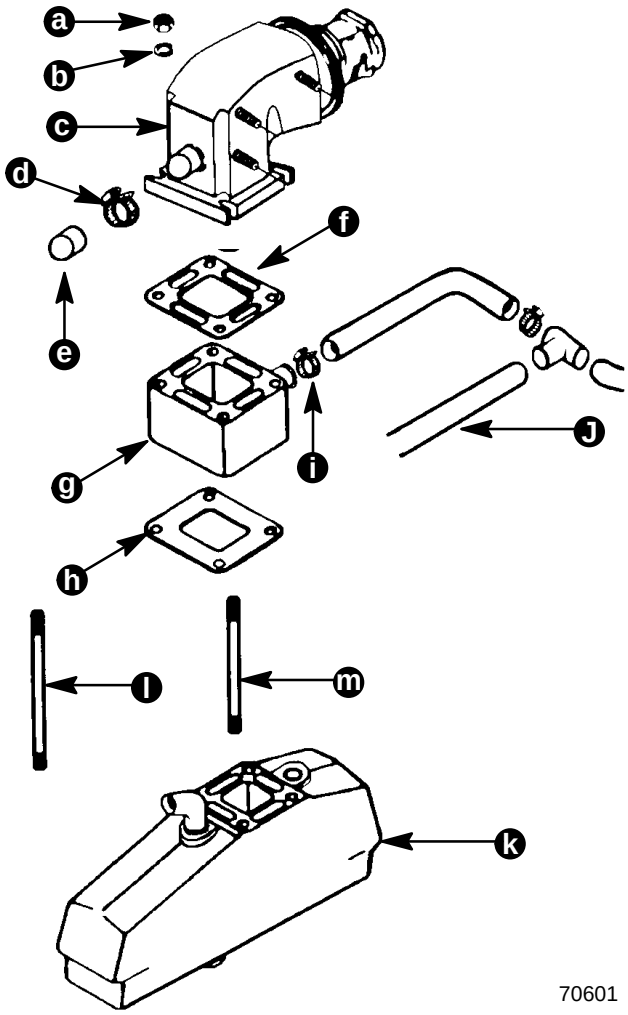
a - Exhaust Manifold
b - Exhaust Elbow
c - Stud 6-1/2 Inch (165 mm)
d - Stud 7-1/2 Inch (191 mm) For Use With Remote Oil Filter
e - Nuts (8)
f - Washers (8)
g - Open Gasket
h - 3 Inch (76 mm) Riser
i - Restrictor Gasket
j - Separator Gasket

Stainless Steel Elbows With Mufflers



a - Exhaust Manifold
b - Exhaust Elbow
c - Stud 9-3/8 Inch (238 mm)
d - Stud 10-3/8 Inch (264 mm) For USe With Remote Oil Filter
e - Washers (8)
f - Nuts (8)
g - Muffler Spacer
h - 3 Inch (76 mm) Riser
i - Open Gasket
j - Restrictor Gasket
k - Separator Gasket

Special Procedure For MCM 454 / 502 Magnum and MIE 8. 2L Bluewater Inboard With Front Mounted Closed Cooling (Serial Number OF801699 and Below)



70601

a - Nut
b - Washer
c - Exhaust Elbow
d - Hose Clamp
e - Block-Off Plug
f - Open Gasket
g - 3 Inch (76 mm) Riser
h - Separator
i - Hose Clamp
j - Hose 19-1/2 Inch (495 mm) To Heat Exchanger
k - Exhaust Manifold
l - Stud 6-1/2 Inch (165 mm)
m - Stud 7-1/2 Inch (191 mm) For Use With Remote Oil Filter

IMPORTANT: Drain plugs in risers must be positioned toward the flywheel.

IMPORTANT: The hoses supplied with the kit for connection between heat exchanger and T-fitting, must be cut to appropriate length.

1. It is necessary to route from back of elbow to front of riser using parts supplied in Kit 17833A7.
2. Install block off plug to fitting in elbow with clamp.
3. Use a soft jaw vise to hold riser and remove 3/4 inch plug from riser.
4. Apply Loctite Pipe Sealant with Teflon to threads of fittings in kit and install in riser.

IMPORTANT: On 454/502 Magnum engines riser fittings point toward flywheel end of engine. On 8.2L MIE Engines the riser fitting points toward the water pump end of engine and there are individual port and starboard hoses from the heat exchanger (no “T”- fitting).

5. Install gaskets between risers as shown. Torque fasteners in a diagonal pattern, to 20-25 (27-34 N·m).
6. Install parts previously removed from engine in appropriate locations using existing fasteners.
7. Install Exhaust Extension Kit for MCM models per instructions in provided in kit.
8. Install heat exchanger to exhaust riser hoses. Secure with hose clamps provided in kit.

Maintenance Instructions

Maintenance inspection is owner's responsibility and must be performed at intervals specified in owner's "Operation and Maintenance Manual".

1. Check to ensure exhaust elbow and manifold fasteners are adequately tightened.
2. Check to ensure hose clamps are adequately tightened.
3. Check area around exhaust elbows, manifolds and riser gaskets for leakage. Replace gaskets, if necessary.
4. **IF THE POSSIBILITY OF FREEZING EXISTS,** remove drain plug from the exhaust elbow riser and allow water to drain completely. Install drain plug with Quicksilver Perfect Seal applied to threads. **In closed cooling MCM 454 / 502 Magnum and MIE 8.2L Bluewater Inboard engines, remove water hose to allow water to drain.**

⚠ CAUTION

Water must be completely drained from exhaust elbow riser during freezing temperatures. Failure to perform draining procedures can cause severe damage.

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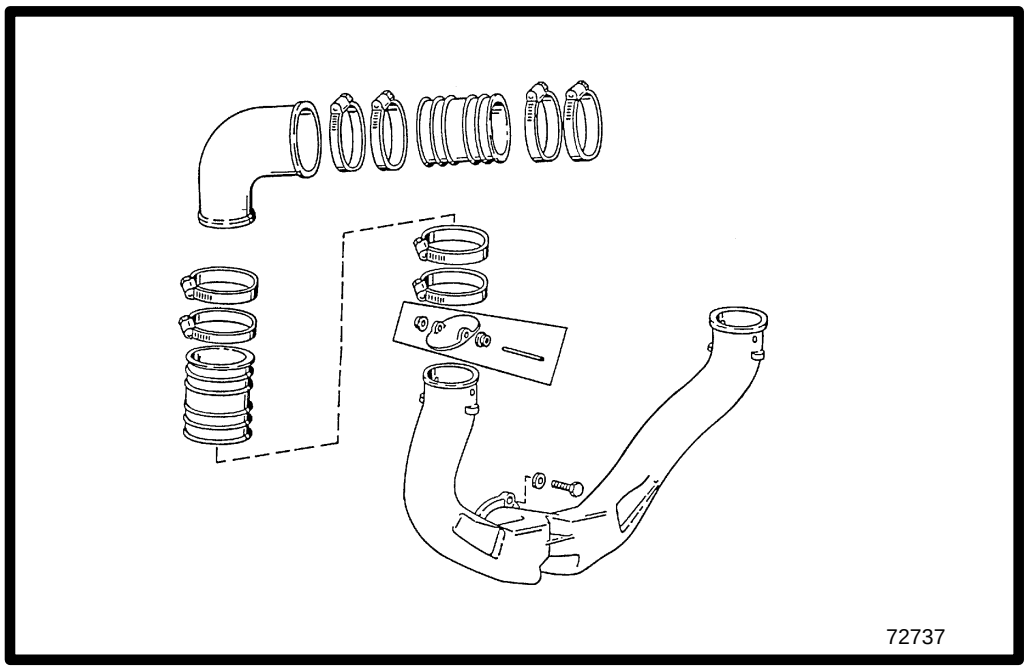
EXHAUST SYSTEM



7

D

COLLECTORS

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Torque Specifications

Fastener Location	Lb. Ft.	N·m
Block-Off Plate	20-25	27-34
Exhaust Pipe to Gimbal Housing		
Exhaust Pipe to Tee Pipe		
Tee Pipe to Gimbal Housing		
Upper Exhaust Pipe to Lower Exhaust Pipe		
Exhaust Elbow		
Air Pump Mount	Securely	
Muffler End Plate		
Mode Switch		
Hose Clamps		
Water Shutter Screw/Nut		

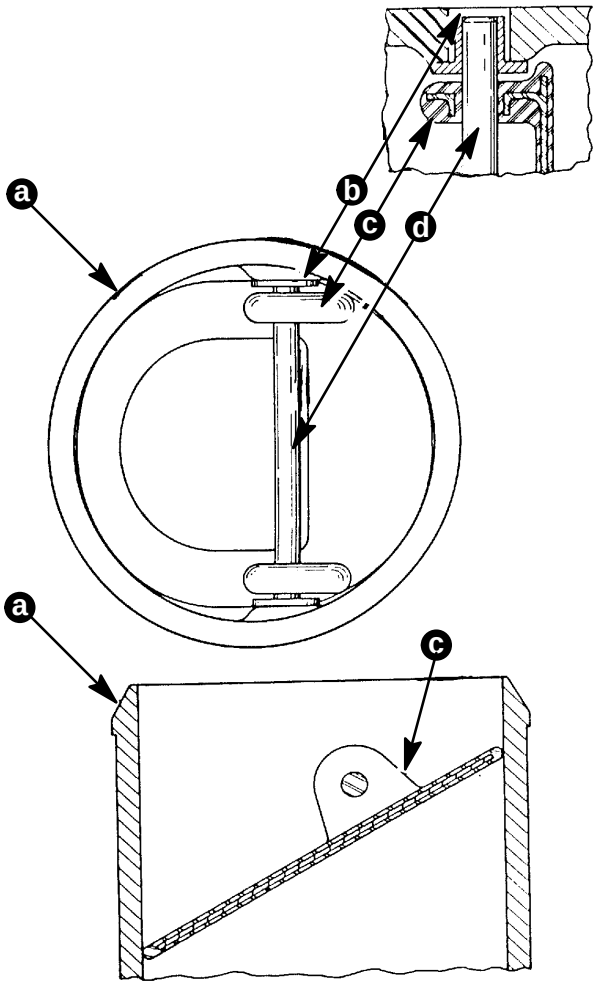
Lubricants/Sealants/ Adhesives

Description	Part Number
Quicksilver 2-4-C Marine Lubricant With Teflon	92-825407A3
Loctite 35	92-59328-1
Loctite Primer	92-59327-1
Quicksilver Bellows Adhesive	92-86166
Quicksilver Perfect Seal	92-34227-1
Quicksilver Liquid Neoprene	92-25711-2
Quicksilver Sound Blanket Glue	92-25234

Shutter Replacement

IMPORTANT: Engine does not have to be removed to change shutters.

1. Loosen clamps and remove exhaust pipe elbow and exhaust hose.
2. Replace water shutter as shown.
3. Reinstall pipe elbow and hose. Tighten clamps securely.



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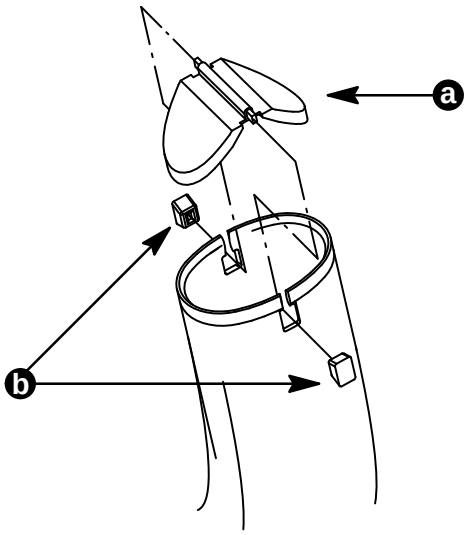
Earlier Style Shutter

a - Top Of Pipe
b - Shoulder Bushing
c - Water Shutter
d - Shaft



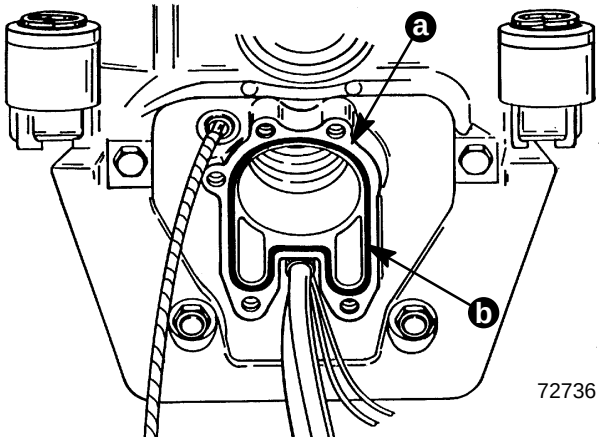
Later Style Shutter

a - Exhaust Flapper
b - Rubber Grommets

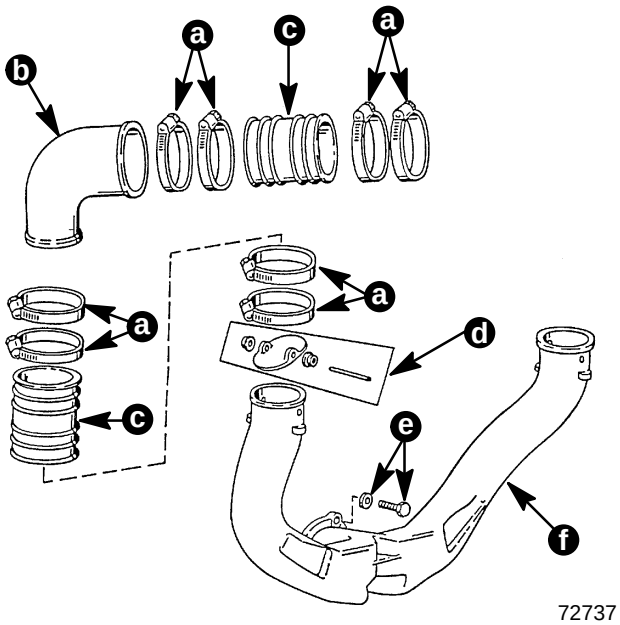
Component Replacement

To replace any components(s) in exhaust system, the following must be adhered to:

- All mating joint surfaces must be clean.
- O-ring must remain in groove to properly seal joints to prevent leakage.
- Torque all bolts to 20-25 lb. ft. (27-34 N·m).
- Tighten all clamps securely.



a - Mating Surface
b - O-Ring

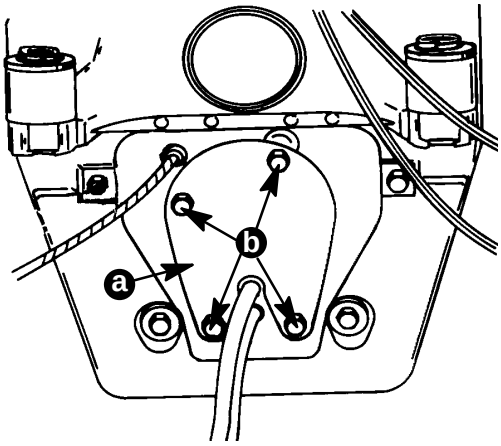


a - Clamps
b - Exhaust Pipe Elbow
c - Exhaust Hose
d - Water Shutters
e - Bolts and Lockwashers
f - Exhaust Pipe

Thru-Transom Exhaust

Shutter Replacement

IMPORTANT: A block off plate must be installed when using thru-transom exhaust or below swim platform kits.



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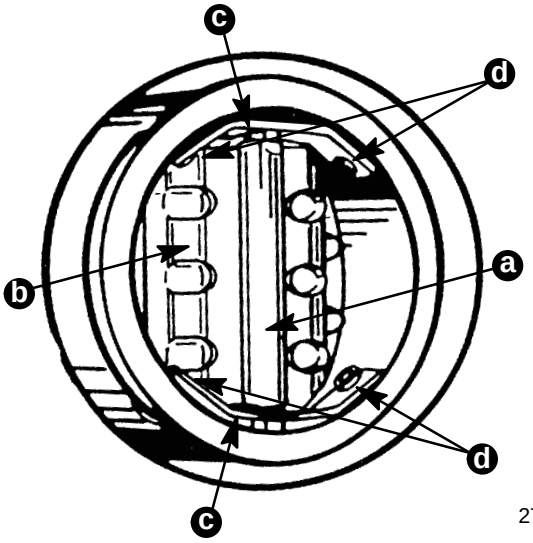
a - Block Off Plate
b - Bolts (4)

1. Remove exhaust hose clamps, then hose.
2. Chisel rivets away from both support members.

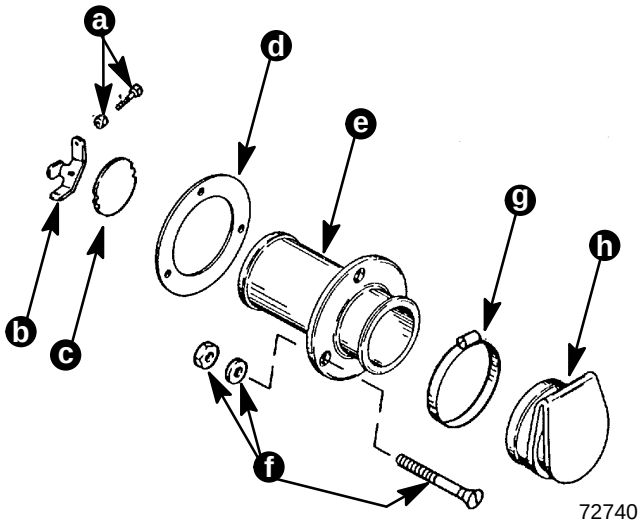


27761

a - Shutter Hinge
b - Water Shutter - Opens Toward Outside Of Boat
c - Support Member
d - Rivets (4)

3. Install new shutter as shown in “Component Replacement” following. Tighten screws and nut securely.
4. Reinstall exhaust hose. Tighten clamps securely.

Component Replacement



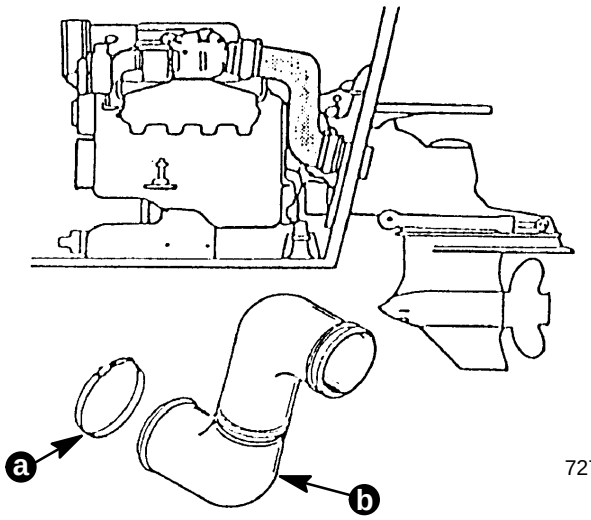
72740

Transom Exhaust Kit

a - Screw And Nut (4)
b - Support Member
c - Water Shutter (Hinge Must Be Vertical)
d - Gasket
e - Exhaust Flange
f - Bolts, Washers and Nuts (3)
g - Clamp
h - Cover (Flapper)

Below Swim Platform Exhaust Pipe Kit

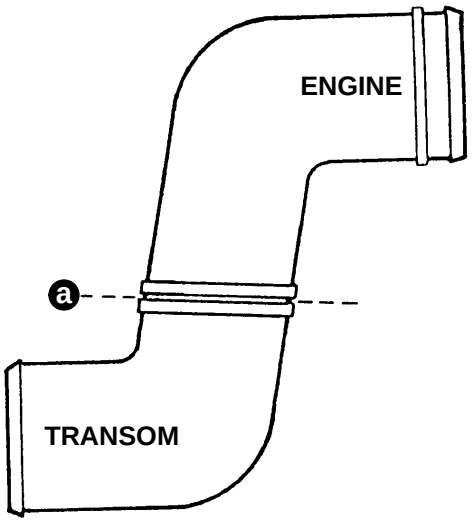
This exhaust kit may be used on any MerCruiser Bravo installation having a 4 in. (102 mm) exhaust elbow.



72742

a - 8 Per Kit
b - 2 Per Kit

Modifying Swim Platform Exhaust Pipe, If Required



72743

a - Cut Line (See Notes)

NOTE: *If riser kits are installed, or if more vertical drop is required, cut "a" must be made, and the upper and lower sections of the pipe rejoined with a 4 in. (102 mm) I.D. exhaust hose of the required length. Secure with hose clamps.*

NOTE: *Prime/paint any raw (cut) aluminum surface.*

IMPORTANT: Each exhaust bellows must be double clamped at each connection, and the hose clamps tightened to 30-40 lb. in. (3-5 N·m).

Silent Choice Exhaust System

If engine is equipped with thru-prop exhaust, a thru-transom kit [4 in. (102 mm)], two exhaust bellows, and eight bellows hose clamps, are required.

If engine is equipped with thru-transom exhaust, an exhaust pipe kit (P/N 44266A6) is required, containing the exhaust pipe and necessary parts.

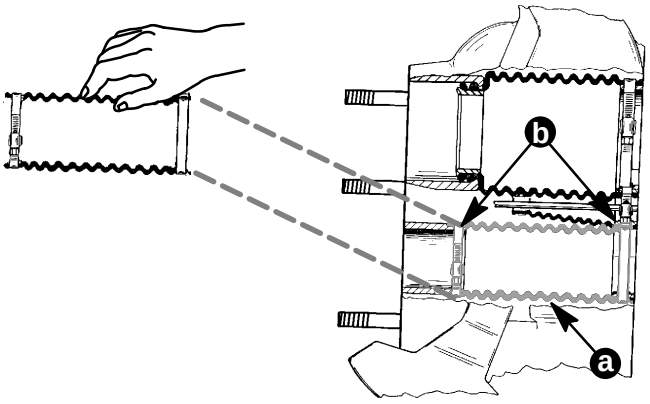
IMPORTANT: <u>When installing Silent Choice exhaust</u>, it is recommended that the exhaust bellows on the transom assembly be removed. This is necessary to avoid creating a vacuum at the exhaust outlet in the propeller at higher boat speeds. This vacuum could degrade propeller performance on some boats.

⚠CAUTION

It is the responsibility of the boat manufacturer or installing dealer to properly locate the engine and install exhaust system. Improper installation may allow water to enter the exhaust manifolds and combustion chambers, and severely damage the engine. Damage caused by water in the engine will not be covered by MerCruiser Warranty, unless this damage is the result of defective part(s).

Exhaust Bellows Removal and Exhaust Tube Installation

1. If required, remove and discard clamps and bellows from gimbal housing.



22116

2. If required, install exhaust tube on gimbal housing as follows:
3. Remove and discard clamps and exhaust bellows.

⚠ CAUTION

Exhaust tube clamp may corrode if grounding clip is not installed.

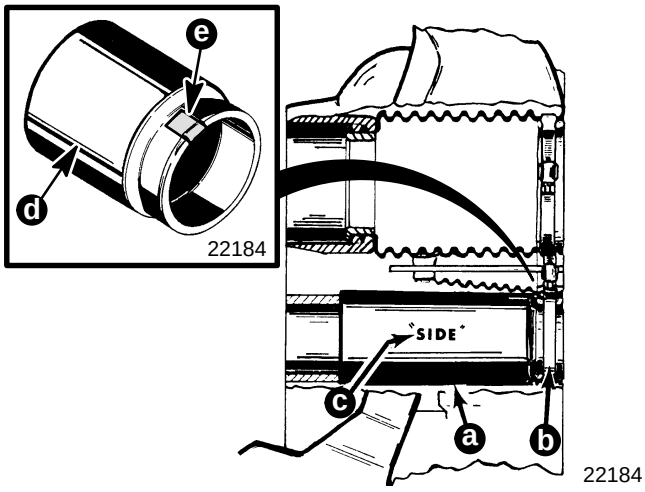
a. Install grounding clip on tube.

NOTE: *Bellows adhesive is not used when installing an exhaust tube.*

(1) Position tube so that “SIDE” markings on tube are facing toward the right and left sides.

(2) Install clamp.

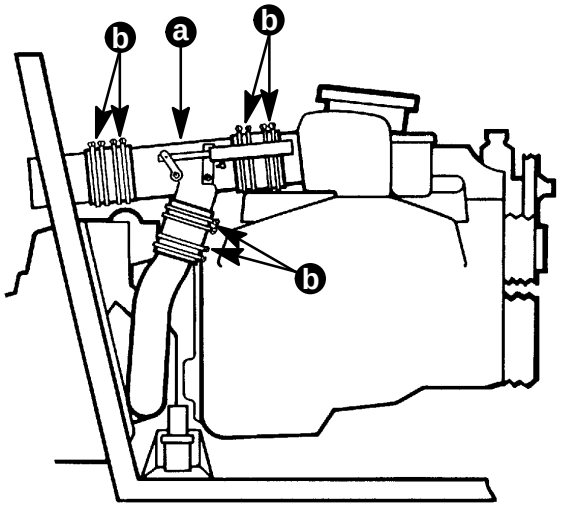
(3) Tighten clamp. Torque to 35 lb. in. (4 N·m).



a - Exhaust Tube
b - Clamp
c - “Side” Marking
d - Exhaust Tube
e - Grounding Clip

⚠ CAUTION

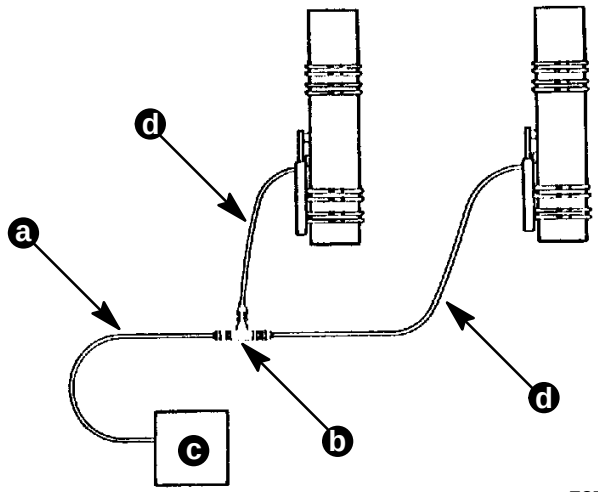
It is the responsibility of the boat manufacturer or installing dealer to properly locate the engine and install exhaust system. Improper installation may allow water to enter the exhaust manifolds and combustion chambers, and severely damage the engine. Damage caused by water in the engine will not be covered by MerCruiser Warranty, unless this damage is the result of defective part(s).



a - Silencer Valve Assembly
b - Hose Clamps

Air Tube Routing

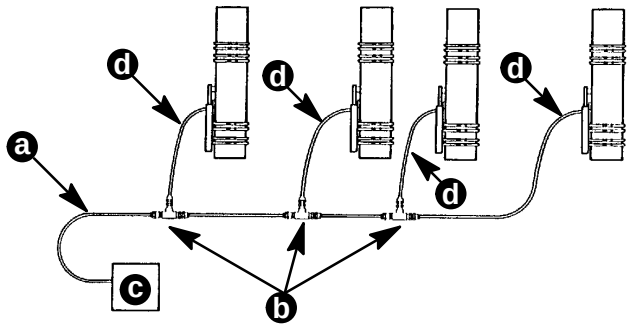
1. Route air tubing from air pump to silencer valve cylinders. Do not route air tubing close to hot surfaces - excessive heat will damage air tubes.



72775

Single Engine

a - Air Tube
b - T-Fittings
c - Air Pump Assembly
d - Air Tube To Air Cylinder - On Each Silencer Valve



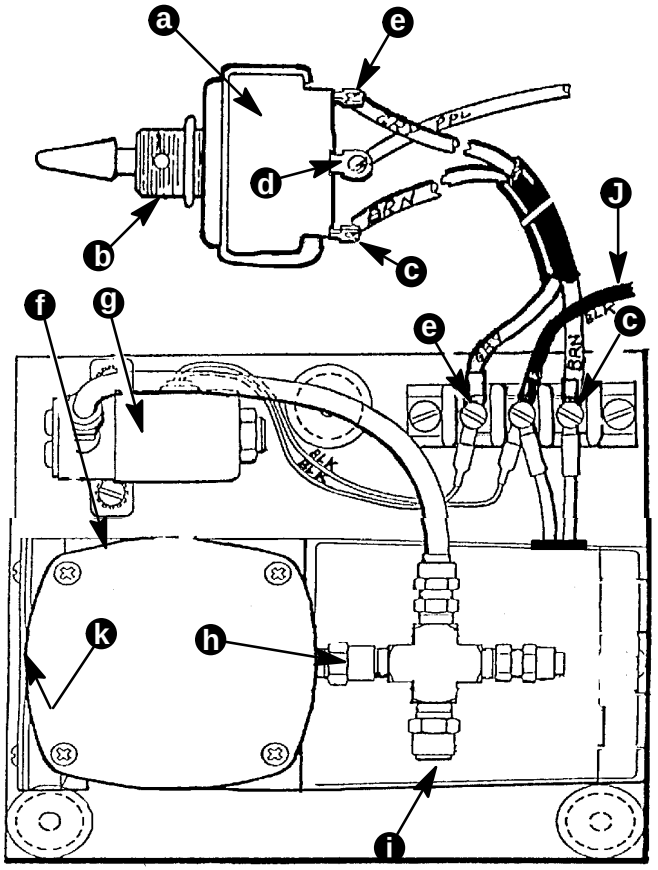
72776

Dual Engine

a - Air Tube
b - T-Fittings
c - Air Pump Assembly
d - Air Tube To Air Cylinder - On Each Silencer Valve

Maintenance

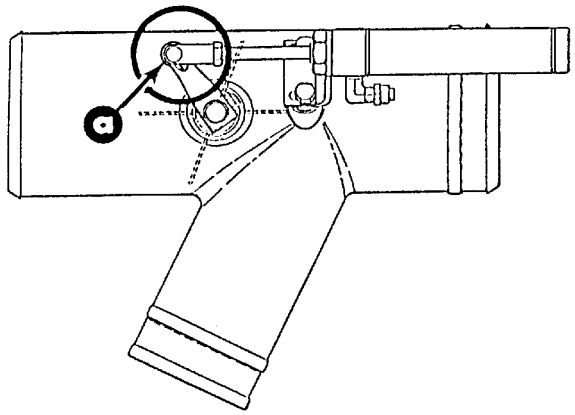
1. Air Intake Filter (32-17272) must be checked once each year. If filter is clogged or partially clogged, replace. The filter pad is glued in, and may be removed with a needle-nose pliers. Clean surface in casting, apply a single dot of Quicksilver Sound Blanket Glue to center of casting, and install new filter. Be careful not to coat filter or clog air intake holes with adhesive.



72534

a - Mode Switch
b - Keyway - Install In DOWN Position
c - BROWN Wire To Terminal 3 - Activates Compressor
d - PURPLE Wire - 12 Volt; Connect To 12 Volt Source In Control Panel Area
e - GRAY Wire To Terminal 1 - Activates Solenoid
f - Air Pump
g - Solenoid
h - Check Valve
i - Relief Valve - 30 PSI
j - 2 Ft. (610 mm) Ground Wire - Connect To Terminal 2 Must Be Grounded To Engine
k - Air Intake Filter

2. Lubricate air cylinder-to-silencer pipe flapper at clevis and pin, as needed, with Quicksilver 2-4-C Marine Lubricant.



72778

a - Lubricate Clevis and Pin with Quicksilver 2-4-C Marine Lubricant

Exhaust Muffler Kit

This muffler, designed for use on all V-8 engines with Plus Power™ exhaust systems (4 in., 7 degrees downward outlets), requires the installation of 1-1/4 in. (32 mm) exhaust elbow risers, which are included in the kit.

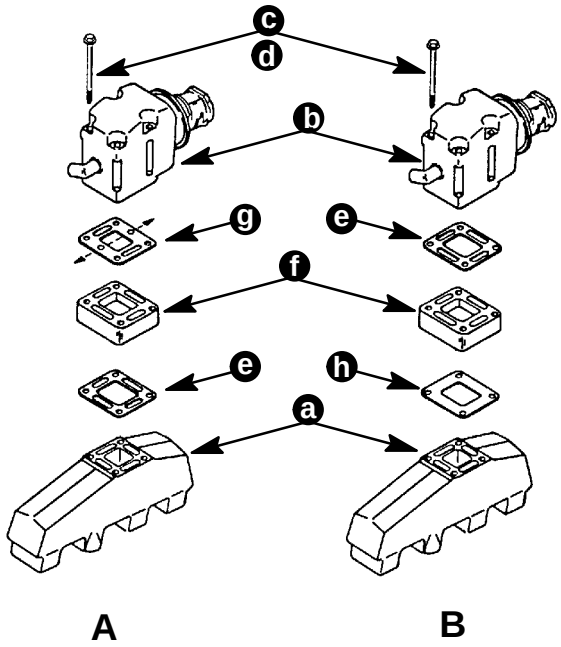
IMPORTANT: If a thru-transom exhaust kit other than the one from Mercury Marine is used, the exhaust kit must be equipped with internal shutters and external flappers.

⚠CAUTION

It is the responsibility of the boat manufacturer or installing dealer to properly locate the engine and install exhaust system. Improper installation may allow water to enter the exhaust manifolds and combustion chambers, and severely damage the engine. Damage caused by water in the engine will not be covered by MerCruiser Warranty, unless this damage is the result of defective part(s).

1-1/4 INCH MUFFLER RISER INSTALLATION, ONLY

IMPORTANT: Restrictor gaskets or separator gaskets must be installed in order shown.



72780

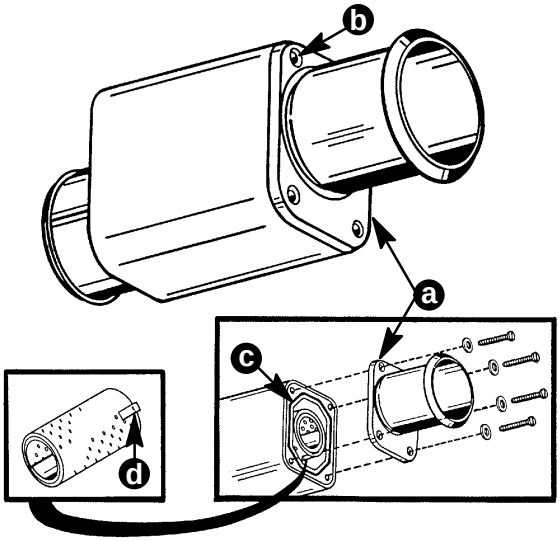
A - Without Separator Gasket
B - With Separator Gasket

a - Exhaust Manifold
b - Exhaust Elbow
c - Bolt (4 Each Manifold)
d - Bolt, Remote OIl Filter Bracket (2)
e - Gasket - Lightly Coat Both Sides With Quicksilver Perfect Seal
f - Riser 1-1/4 Inch (32 mm) Height
g - Restrictor Gasket
h - Manifold Separator Gasket

NOTE: *Drain plugs in risers face toward stern.*

Cleaning and Inspection

1. Disassemble muffler as shown.



72782

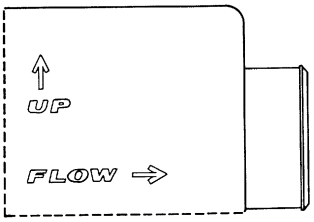
a - Removable End Plate
b - 4 Screws Secure End Plate
c - O-Ring Seal
d - Element - When Reassembling, Seat Tab In Slot In Casting

2. Clean (using pressurized water) and inspect parts, including filter element and O-ring seal. If required, replace O-ring, securing in place with Quicksilver Sound Blanket Glue.
3. Reassemble as shown above. Tighten end plate screws securely.

Installation

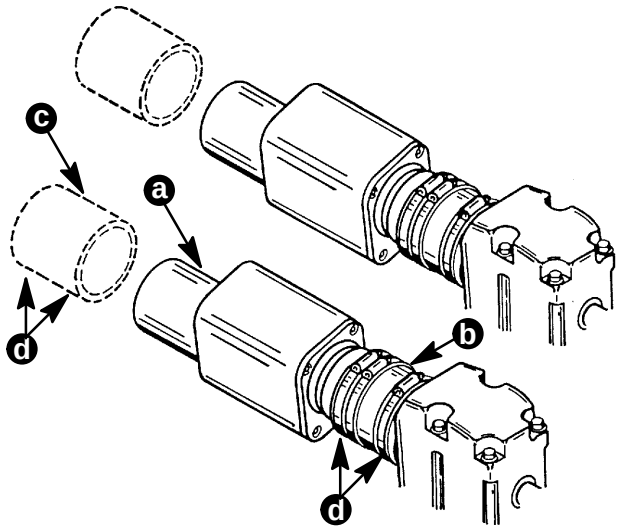
1. Install muffler, as shown, into exhaust hose and molded tube. Fabricate muffler to transom using 4-inch I.D. exhaust hose, cut to required length.

NOTE: *Removable end of muffler ALWAYS goes toward exhaust elbow. This places direction marks on muffler body casting at the upper rear corner on the port side.*



72783

IMPORTANT: A MOLDED exhaust tube MUST be used at exhaust elbow connection to maintain positive separation of exhaust outlet and muffler inlet.



72781

a - Muffler
b - Molded Exhaust Tube - Muffler To Elbow
c - Exhaust Hose - Muffler To Thru Transom Fitting - Cut To Length
d - Double Clamp Each Connection (Not Shown On Hose C)

2. Double clamp each connection; tighten each clamp securely.

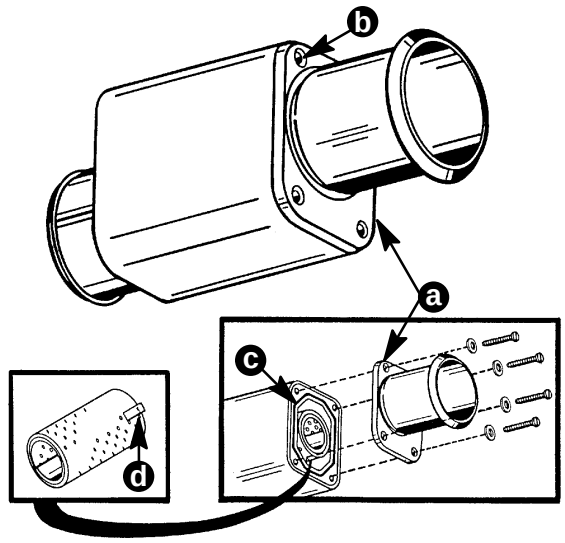
IMPORTANT: After starting engine, check installation for leaks.

Maintenance Instructions

Maintenance inspection is owner's responsibility and must be performed at intervals specified in owner's Operation and Maintenance Manual.

1. Check exhaust elbow attaching nuts for adequate tightness [20-25 lb. ft. (27-34 N·m)].
2. Check hose clamps for adequate tightness.
3. Periodically check tubes/hoses for soft spots, brittleness, cracks, and general condition. Replace as necessary.

4. As needed, depending on use conditions, remove mufflers, then remove four screws securing forward end plate, and remove end plate and element and interior of muffler. Clean thoroughly, at least once each year, using pressurized water.



72782

a - Removable End Plate
b - 4 Screws Secure End Plate
c - O-Ring Seal
d - Element - When Reassembling, Seat Tab In Slot In Casting

   a. Check condition of O-ring seal; if dried out or shrunk below mating surface, remove and replace. Clean groove thoroughly.

   b. Glue new O-ring seal in groove, using Sound Blanket Glue. Wipe off excess glue immediately.

5. Reinstall muffler end plate with four screws. Tighten securely.
6. Reinstall muffler into tubes/hoses. Double clamp. Tighten securely.
7. Check area around exhaust elbow and riser gaskets for leakage. Replace gaskets, if necessary.
8. If the possibility of freezing exists, remove drain plug from exhaust elbow riser and allow water to drain completely. Reinstall drain plug with Quicksilver Perfect Seal applied to threads.

⚠CAUTION

Water must be completely drained from exhaust elbow riser during freezing temperatures, or water may freeze and cause severe damage to riser.

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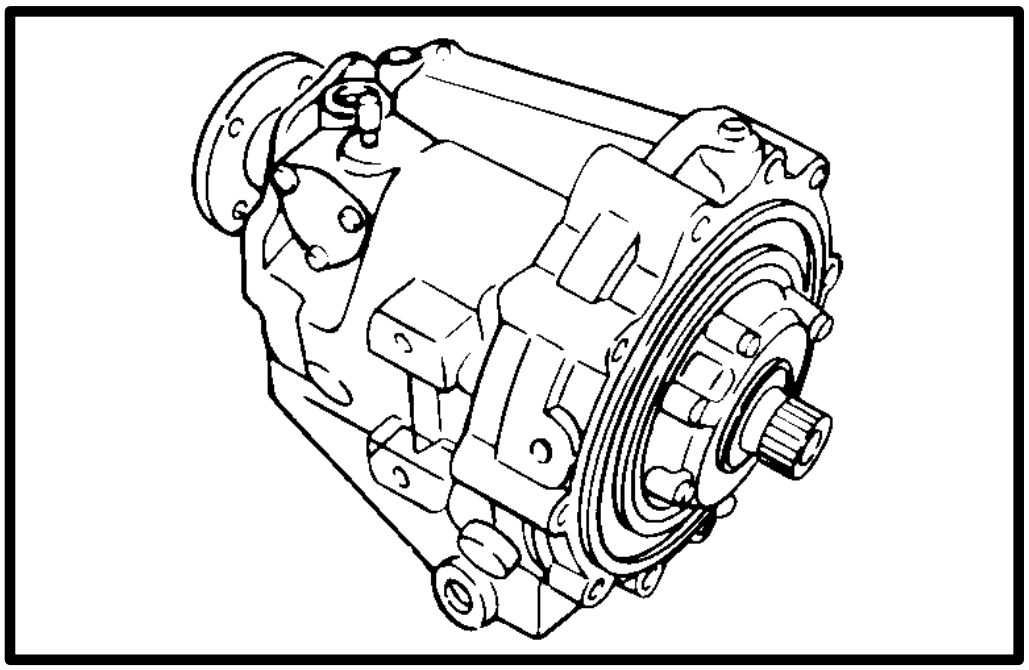
DRIVES



VELVET DRIVE IN-LINE TRANSMISSION

8

A

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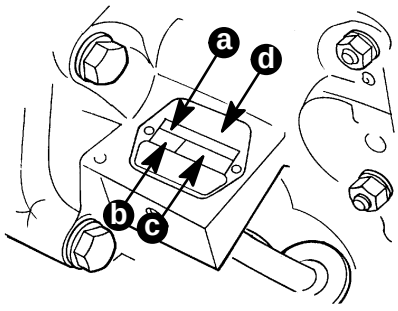
Velvet Drive In-Line (71C and 72C) Specifications

The transmission identification plate is located on the top left side of the transmission. Refer to charts following to determine engine and transmission combinations



72839

Transmission Identification Plate

a - Model Number
b - Ratio (in Forward Gear)
c - Serial Number
d - Identification Plate Model Color Code

Transmission Ratios

Ratio in Forward Gear (NOTE 1 & 2)	Identification Plate Color Code
1:1	Red
1:1	Green
1.5:1	
2.5:1	
2.91:1	Green

NOTE: 1. This ratio is shown on identification plate. Ratio may be rounded off in some cases.

NOTE 2: These transmissions are for LH (standard) rotation engines, and the propeller shaft rotation is LH (standard) when in forward gear.

Torque Specifications

DESCRIPTION	Lb. Ft.	N·m
Drain Plug (Bushing)	25	34
Fluid Hose to Bushing	25	34
Pump Housing to Adapter	17-22	23-29
Rear Mounts to Transmission	45	61
Shift Lever to Valve	8-11	11-15
Transmission to Flywheel Housing	50	68
Neutral Start Switch	8-11	11-14

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Transmission Fluid Capacities

MODEL	U.S. QTS. (LITRES)
71C and 72C	1-1/2 (1.3) (See Note)
71C and 72C Reduction	2-1/2 (2.4) (See Note)

NOTE: *Use dipstick to determine fluid exact level.*
Warm Fluid Level Check: *The transmission should be at operating temperature [190° F(90° C)] maximum to receive an accurate oil level reading.*
Cold Fluid Level Check: *To ease checking fluid level, the dipstick can be marked or scribed. First the procedure for warm fluid level must be performed, then allow boat to sit overnight. Remove and wipe clean the dipstick. Insert clean dipstick and mark the cold fluid level.*

Transmission Pressure Specifications

Engine RPM	Neutral Gear PSI (kPa)		Forward Gear PSI (kPa)		Reverse Gear PSI (kPa)	
	MIn.	Max.	Min.	Max.	Min.	Max.
250			70 (483)		70 (483)	
600	115 (793)	135 (931)	115 (793)	140 (965)	120 (827)	140 (965)
2000			125 (862)	160 (1103)	125 (862)	160 (1103)
3000			135 (931)	180 (1241)		

Transmission Output Shaft Rolling Torque

NOTE: *Transmission is not installed on engine, no fluid in transmission. Use torque wrench and socket on coupling nut.*

MODEL	RATIO	Lb. In.	N·m
71C	1:1	50 Max.	68 Max.
72C	1:1	50	70

Transmission Fluid Specification

Transmission Type	ATF (Dexron III)	Mobil 424
71C Direct Drive	X	
71C Reduction Drive		X
71C V-Drive		X
72C Direct Drive	X	
72C Reduction Drive		X
72C V-Drive		X

NOTE: *Transmissions (except reduction drive transmissions) supplied with Mobil 424 can be changed to ATF Dexron III, but transmission must be flushed and refilled at least twice (this includes lines and cooler).*

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Important Information

Shift Control and Cables

⚠CAUTION

Shift control and shift cable must position transmission shift lever exactly as stated in this manual, or transmission, as a result of improper shift lever positioning, will not be covered by Borg-Warner Warranty.

IMPORTANT: Velvet Drive Warranty is jeopardized if the shift lever poppet ball or spring is permanently removed, or if shift lever is repositioned or changed in any manner.

Remote control used must position transmission shift lever over the letter “F” embossed on transmission case when remote control is placed in forward gear position. Transmission failure will occur if transmission shift lever is positioned over the letter “R” and the wrong rotation propeller is used to propel boat forward.

Remote control also must provide a total shift cable travel (at transmission end) of at least 2-3/4 in. (70 mm). This is necessary to position transmission shift lever fully in the forward and reverse gear positions. Insufficient shift cable travel will cause transmission to slip and eventually fail.

Engine

Engine rotation is indicated on engine specifications and serial number decal on flame arrestor cover. Engine rotation is described when observed from the rear of the engine (transmission end) looking forward (water pump end).

Installed angle of MIE inboard transmission and engine should not exceed a maximum of 18° of the water line.

Transmission

Transmission gear ratio (in forward gear) is marked on transmission identification plate, which is located on the port (left) side of transmission. Transmission output shaft rotation and propeller rotation required is indicated on a decal on transmission case. Transmission rotation is described when viewed from the rear of transmission with transmission in forward gear selector position.

On MIE engines equipped with in-line transmissions having 1:1 or 3:1 gear ratios, transmission output shaft rotation is the same as engine rotation with transmission in forward gear. Engine rotation is LH (CCW), so a LH propeller is required.

1. DO NOT start or crank engine without fluid in transmission.
2. Use only recommended fluid in transmission.
3. Except in an emergency, never shift transmission at engine speeds above 1000 RPM.
4. Free wheeling of one propeller (in a twin engine boat), at trolling speeds, will not cause damage to the transmission; however, boat operation above trolling speed should be avoided. Be sure proper fluid level exists before free wheeling propeller.
5. DO NOT paint shift lever poppet ball and spring. An accumulation of paint here will prevent proper action of the detent.
6. Always replace oil cooler and hoses after a transmission failure or prior to installing a new or rebuilt transmission. Metallic particles from a failure tend to collect in the cooler and hoses and will gradually flow back into the fluid system and damage transmission.
7. Always use specified oil cooler, hoses and fittings. Hoses must be at least 13/32 in. (10.5 mm) I.D. Oil cooler, hoses and fittings must be sufficient size to maintain transmission fluid (in sump) at 140-190°F (60-88°C).

Propeller

Propeller rotation is described when observed from the rear of the boat (stern) looking forward (bow end). The term “left-hand” (LH) refers to rotation in the counterclockwise (CCW) direction. The term “right-hand” (RH) refers to rotation in the clockwise (CW) direction. A LH propeller will move the boat forward when rotated counterclockwise. A RH propeller will move the boat forward when rotated clockwise. Propeller rotation is not necessarily the same as engine rotation.

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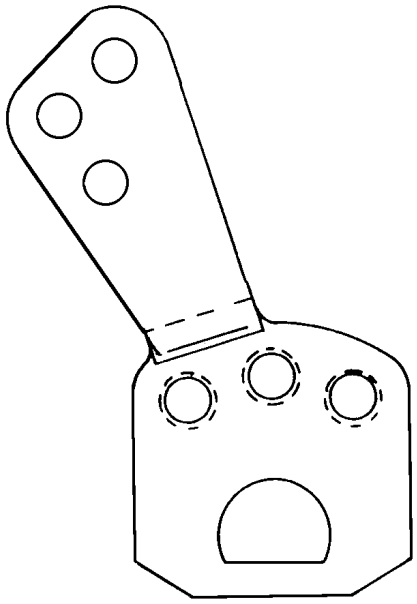
Transmission Shift Lever

The lever has three holes as illustrated following.



71304

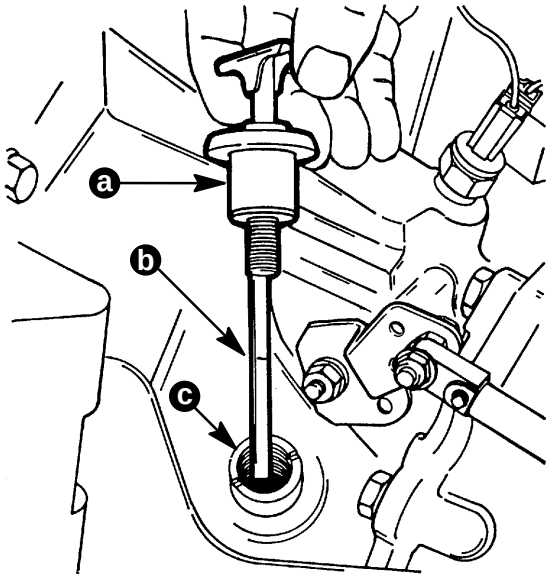
Shift Cable Adjustment

Refer to Section 2C - “MIE Models - Borg-Warner Transmissions.”

Checking Transmission Fluid Level

IMPORTANT: Use only specified transmission fluid (see “Specifications”).

IMPORTANT: To accurately check fluid level, engine must be run at 1500 RPM for 2 minutes immediately prior to checking level.



72526

a - Dipstick
b - Full Mark
c - Dipstick Tube

1. Start engine and run at 1500 RPM for 2 minutes to fill all hydraulic circuits.

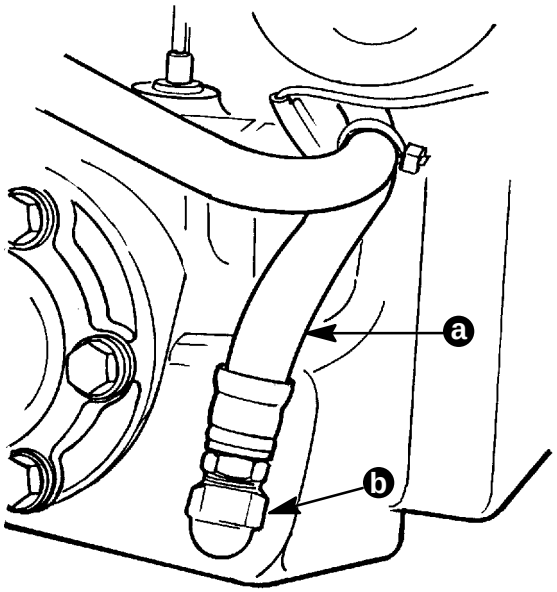
IMPORTANT: Be sure to push dipstick all the way down into dipstick tube when checking fluid level.

2. Stop engine and check fluid level. Add transmission fluid, if necessary, to bring level up to full mark on dipstick.
3. Reinstall dipstick. Be sure to tighten T-handle securely. DO NOT over tighten.
4. If transmission fluid level was extremely low, carefully check transmission, fluid cooler and hoses for leaks.

Changing Transmission Fluid

Draining Transmission

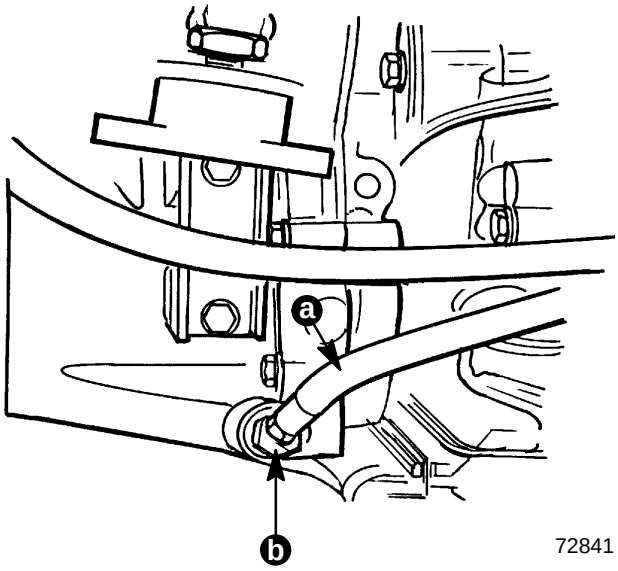
1. Clean area around cooler hose shown and proceed as follows:
   a. Disconnect hose from elbow fitting.
   b. Remove elbow fitting from bushing.
   c. Drain oil from transmission, cooler, and cooler hoses into a suitable container.



72840

Transmission With 1:1 Ratio

a - Hose
b - Elbow Fitting

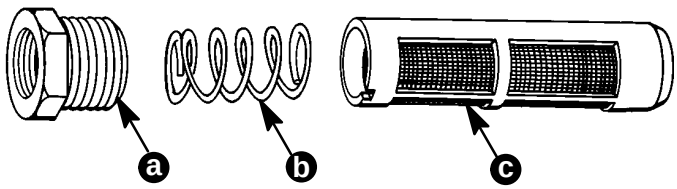


72841

Transmission with Reduction Ratios

a - Hose
b - Bushing

2. Remove bushing, spring and strainer tube from transmission case. Allow transmission to drain completely.
3. Clean strainer tube in suitable solvent.



71307

a - Bushing
b - Spring
c - Plastic Strainer Tube

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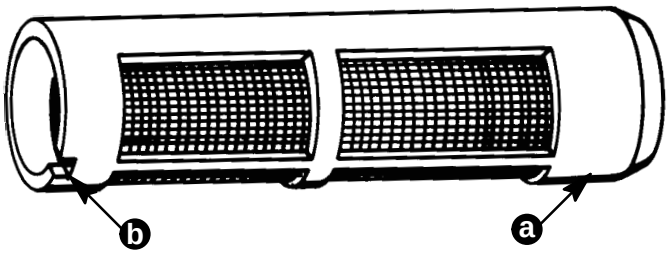
4. Check oil for the following foreign matter:
   - **Metal Particles -** A few small particles are normal. Larger metal chips are an early sign of transmission failure which may mean transmission should be disassembled and inspected for internal damage.
   - **Rubber Particles -** Indication of cooler hose wear. Hoses should be inspected for cracks or fraying. Replace damaged hoses.

⚠CAUTION

Avoid severe transmission damage or possible failure of transmission. Strainer must be properly installed as follows.

5. Install plastic strainer tube with the notch DOWN and OUT toward the side of the case.



71306

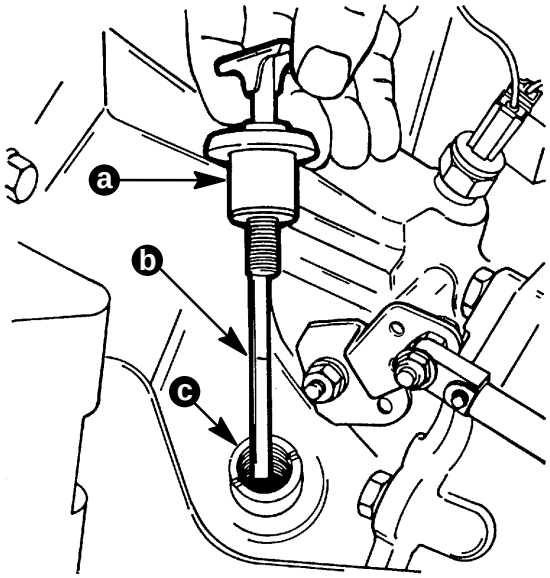
a - Plastic Strainer Tube
b - Notch

6. Install spring.
7. Coat bushing threads with Quicksilver Perfect Seal. Install and torque bushing to 25 lb. ft. (34 N·m).
8. Coat elbow fitting threads with Quicksilver Perfect Seal and install in bushing. Tighten securely.
9. Reconnect hose and tighten securely.

Filling Transmission

IMPORTANT: Use only specified transmission fluid (see "Specifications").

1. Remove dipstick. Fill transmission with fluid, through dipstick hole, to bring up to full mark.



72526

a - Dipstick
b - Full Mark
c - Dipstick Tube

IMPORTANT: To accurately check fluid level, run engine at 1500 RPM for 2 minutes immediately prior to checking level.

2. Start engine and run at 1500 RPM for 2 minutes to fill all hydraulic circuits.

NOTE: Be sure to push dipstick all the way down into dipstick tube when checking fluid level.

3. Stop engine and quickly check fluid level. Add transmission fluid, if necessary, to bring level up to full mark on dipstick.
4. Reinstall dipstick. Be sure to tighten T-handle securely.

Removal and Installation

NOTICE

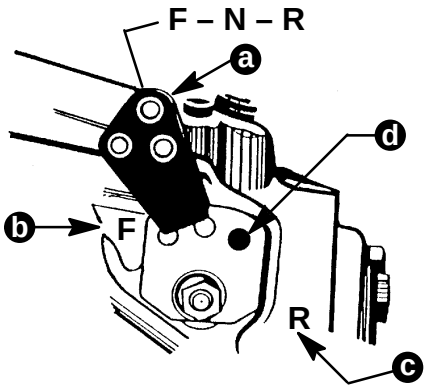
The following procedure describes removal of transmission without removing engine. If engine must be removed, refer to Section 2 (see "Table of Contents").

1. Drain transmission fluid.
2. Disconnect fluid cooler hoses.
3. Disconnect shift cable.
4. Disconnect wires from neutral start safety switch.
5. Disconnect TAN/BLUE wire from fluid temperature switch.
6. Disconnect propeller shaft coupling.
7. Remove four rear mount (to engine bed) bolts.
8. Support rear part of engine with either a hoist or by using wooden blocks under flywheel housing.
9. Remove two center transmission-to-flywheel housing attaching bolts and install two long studs.

IMPORTANT: These two long studs will help support weight of transmission during removal and installation.

10. Remove remaining transmission attaching bolts.
11. Pull transmission straight back and off engine.
12. Before installing transmission, check transmission pump indexing for correct rotation. Refer to "Pump Indexing."
13. Check transmission output shaft rolling torque. See "Specifications."
14. Apply Quicksilver Engine Coupler Spline Grease to transmission input shaft splines and engine drive plate splines.
15. If removed, install rear engine mounting brackets (to transmission) as outlined in Section 3 (see "Table of Contents"). Torque to 45 lb. ft. (61 N·m).
16. Align transmission splines with drive plate splines.
17. Slide transmission into place and secure with bolts.
18. Remove two long studs (installed in Step 9) and install remaining two bolts. Torque all bolts to 50 lb. ft. (68 N·m).
19. Relieve hoist tension and fasten rear engine mounts to engine bed. Tighten bolts securely.
20. Connect wires to neutral start safety switch.
21. Connect tan/blue wire to fluid temperature switch.
22. Connect fluid cooler hoses to transmission.
23. Connect and adjust shift cable(s) as outlined in Section 2C - "MIE Models - Velvet Drive Transmissions."

IMPORTANT: Velvet Drive Transmission Warranty is jeopardized if the shift lever poppet ball or spring is permanently removed, if the shift lever is repositioned or changed in any manner, or if remote control and shift cable do not position shift lever exactly as shown.



72601

a - Transmission Shift Lever
b - Shift Lever Must Be Over This Letter when Propelling Boat FORWARD
c - Shift Lever Must Be Over This Letter when Propelling Boat in REVERSE
d - Poppet Ball Must Be Centered in Detent Hole for Each F-N-R Position (Forward Gear Shown)

24. Refer to Section 2C - "MIE Models - Velvet Drive Transmissions" and check engine final alignment as outlined.
25. After engine has been properly aligned, connect propeller shaft coupler to transmission output flange. Attach couplers together with bolts, lockwashers and nuts. Torque to 50 lb. ft. (68 N·m).
26. Refill transmission with specified fluid. Refer to "Filling Transmission."
27. Check for leaks and check fluid level after first engine start-up.

index

Pump Indexing

Pump must be correctly indexed to correspond with engine rotation. If pump is not indexed correctly, pump will not create fluid pressure allowing the transmission to shift. Pump housing has two arrows, each pointing in a different direction. Pump must be positioned so that the arrow (pointing in the direction that input shaft and pump will be turned by engine) is at the top of transmission.

⚠CAUTION

Position pump housing with cast arrow at top pointing in the same direction as engine rotation.

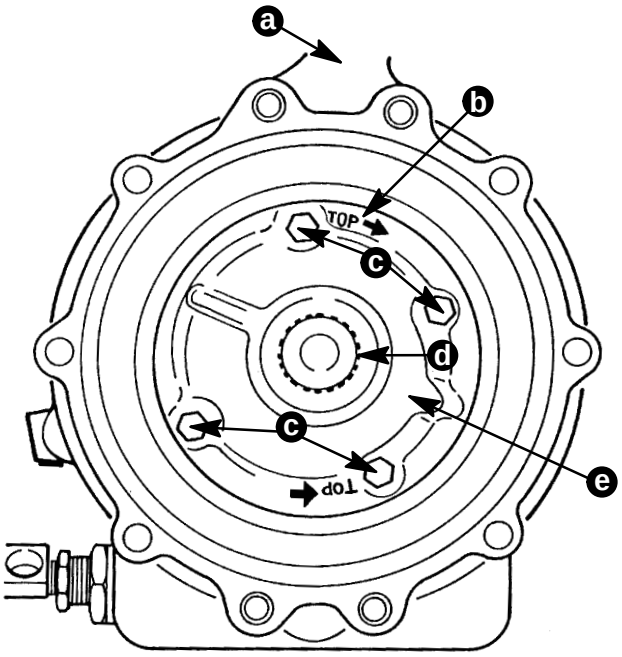
IMPORTANT: Some transmissions have letters "RH" and "LH" on pump housing. Letters DO NOT indicate shaft rotation.

If pump must be indexed, proceed as follows:

1. Remove four pump attaching bolts.
2. Loosen the pump housing. A soft tip mallet may be used to tap the fluid passage boss. Do not strike the bolt bosses.

IMPORTANT: Do not remove the pump from the shaft unless a seal protector is used to prevent the shaft splines from cutting the pump seal. Care must be taken to ensure that seal, gasket, seal and bolt bosses are kept in good condition to prevent leaks in those critical areas.

3. Make sure that pump gasket is not sticking to housing (to prevent gasket from tearing or folding) when rotating pump.
4. Rotate pump until arrow indicating the proper direction of pump rotation is near the top of transmission.
5. Reinstall four pump-to-adaptor attaching bolts and torque to 204-264 lb. in. (23-29 N·m).



72842

MIE LH (Standard) Rotation Engine

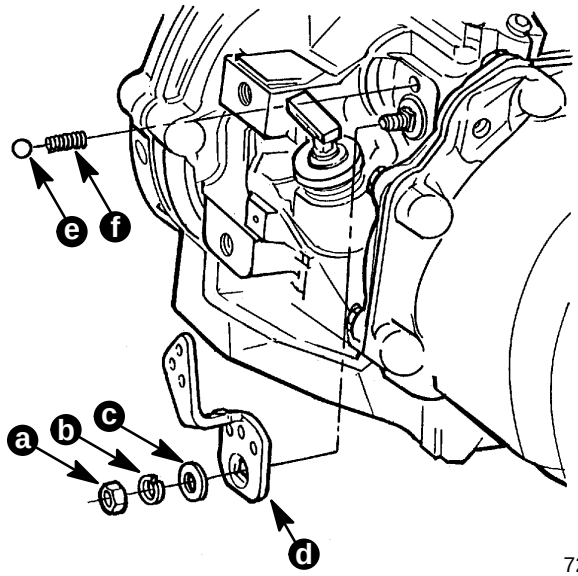
a - Top Of Transmission
b - Word "Top" and Cast Arrow
c - Pump Attaching Bolts
d - Input Shaft
e - Pump Assembly

Shift Lever Installation

IMPORTANT: Borg-Warner Warranty is jeopardized if the shift lever poppet spring and/or ball is permanently removed, or if the shift lever is changed in any manner, or repositioned, or if the linkage between the remote control and the transmission shift lever does not have sufficient travel in both directions.

Shift lever and related parts must be assembled as shown.

1. Lubricate poppet ball, spring, and holes in shift lever with Quicksilver 2-4-C Marine Lubricant.
2. Install poppet spring and ball. Retain ball by placing shift lever on shaft.
3. Install flat washer, lockwasher and nut on shaft.
4. Torque nut to 96-132 lb. in. (11-15 N·m).



72844

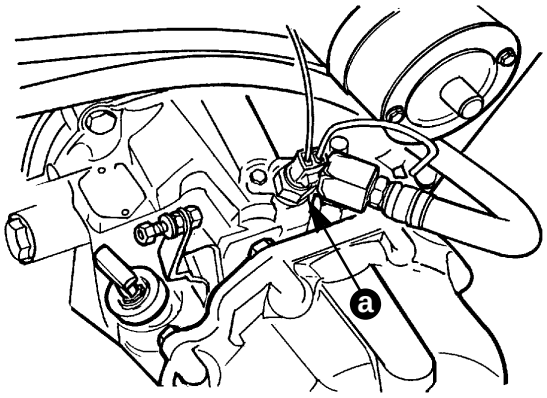
Typical Shift Lever

a - Nut
b - Lockwasher
c - Flat Washer
d - Shift Lever
e - Poppet Ball
f - Poppet Spring

5. After installation, move shift lever through forward, neutral and reverse positions. No more than finger-tip effort should be required. If valve binds, cause for binding must be found and corrected.

Pressure Test

1. Install pressure gauge.



72845

a - Main Line Pressure Tap - Remove Temperature Switch

2. With boat in water, start engine and run until normal operating temperature is reached.
3. Refer to “Specifications” (see “Table of Contents”) for pressure readings.

Transmission Repair

Mercury Marine does not stock or sell replacement parts for the in-line transmission. Velvet Drive has a network of distributors throughout the world to service their product. These distributors, in turn, have a dealer network to service the transmissions. Also, service manuals (for each transmission) can be obtained from .

IMPORTANT: Refer to “Special Replacement Part Information” before working on transmission.

For the location of your closest distributor or service literature contact:

Velvet Drive Transmissions
Division Of Regal Beloit
Theodore Rice Boulevard
Industrial Park
New Bedford, MA 02745
Phone: (508) 995-2616

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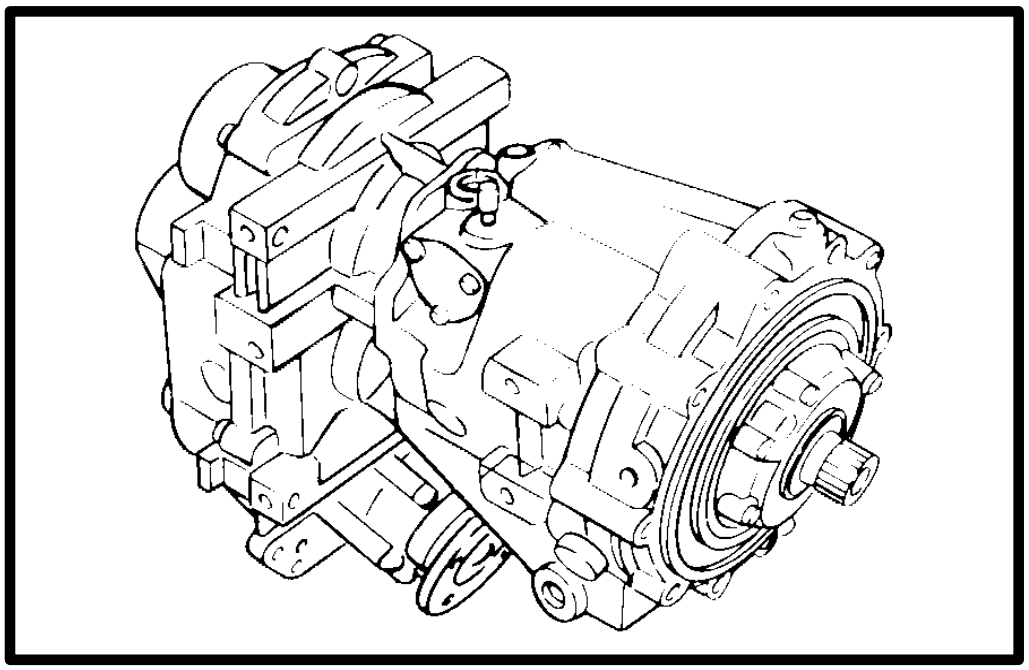
DRIVES



VELVET DRIVE V-DRIVE TRANSMISSION

8

B

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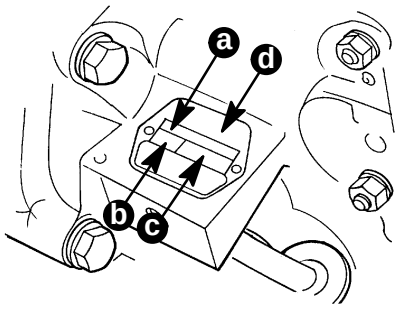
Identification

The transmission identification plate is located on the top left side of the transmission. Refer to charts following to determine engine and transmission combinations.



72839

Transmission Identification Plate

a - Model Number
b - Ratio (in Forward Gear)
c - Serial Number
d - Identification Plate Model Color Code

Transmission Ratios

Ratio in Forward Gear (NOTE 1 & 2)	Identification Plate Color Code
1.5:1	Red
1.99:1	
2.49:1	

NOTE: 1. This ratio is shown on identification plate. Ratio may be rounded off in some cases.

Torque Specifications

DESCRIPTION	Lb. Ft.	N·m
Drain Plug (Bushing)	25	34
Fluid Hose to Bushing	25	34
Pump Housing to Adapter	17-22	23-29
Rear Mounts to Transmission	45	61
Shift Lever to Valve	8-11	11-15
Transmission to Flywheel Housing	50	68
Neutral Start Switch	8-11	11-14

Transmission Fluid Capacities

MODEL	U.S. QTS. (LITRES)
71C V-Drive and 72C V-Drive	3 (2-3/4) (See Note)

NOTE: *Use dipstick to determine fluid exact level.*
Warm Fluid Level Check: *The transmission should be at operating temperature [190° F(90° C)] maximum to receive an accurate oil level reading.*
Cold Fluid Level Check: *To ease checking fluid level, the dipstick can be marked or scribed. First the procedure for warm fluid level must be performed, then allow boat to sit overnight. Remove and wipe clean the dipstick. Insert clean dipstick and mark the cold fluid level.*

Transmission Pressure Specifications

Engine RPM	Neutral Gear PSI (kPa)		Forward Gear PSI (kPa)		Reverse Gear PSI (kPa)	
	MIn.	Max.	Min.	Max.	Min.	Max.
250			70 (483)		70 (483)	
600	115 (793)	135 (931)	115 (793)	140 (965)	120 (827)	140 (965)
2000			125 (862)	160 (1103)	125 (862)	160 (1103)
3000			135 (931)	180 (1241)		

Transmission Output Shaft Rolling Torque

NOTE: *Transmission is not installed on engine, no fluid in transmission. Use torque wrench and socket on coupling nut.*

MODEL	Lb. In.	N·m
71C V-Drive (All Ratios)	50 Max.	68 Max.
72C V-Drive (All Ratios)	50	70

Transmission Fluid Specification

71C V-Drive and 72C V-Drive	Mobil 424

NOTE: *Transmissions (except reduction drive transmissions) supplied with Mobil 424 can be changed to ATF Dexron III, but transmission must be flushed and refilled at least twice (this includes lines and cooler .*

Important Information

Shift Control and Cables

⚠CAUTION

Shift control and shift cable must position transmission shift lever exactly as stated in this manual, or transmission, as a result of improper shift lever positioning, will not be covered by Velvet Drive Warranty.

IMPORTANT: Velvet Drive Warranty is jeopardized if the shift lever poppet ball or spring is permanently removed, or if shift lever is repositioned or changed in any manner.

Remote control used must position transmission shift lever over the letter “F” embossed on transmission case when remote control is placed in forward gear position. Transmission failure will occur if transmission shift lever is positioned over the letter “R” and the wrong rotation propeller is used to propel boat forward.

Remote control also must provide a total shift cable travel (at transmission end) of at least 2-3/4 in. (70 mm). This is necessary to position transmission shift lever fully in the forward and reverse gear positions. Insufficient shift cable travel will cause transmission to slip and eventually fail.

Engine

Engine rotation is indicated on engine specifications and serial number decal on flame arrestor cover. Engine rotation is described when observed from the rear of the engine (transmission end) looking forward (water pump end).

Installed angle of MIE inboard transmission and engine should not exceed a maximum of 18° of the water line.

Transmission

Transmission gear ratio (in forward gear) is marked on transmission identification plate, which is located on the port (left) side of transmission. Transmission output shaft rotation and propeller rotation required is indicated on a decal on transmission case. Transmission rotation is described when viewed from the rear of transmission with transmission in forward gear selector position.

On MIE engines which are equipped with V-drive transmissions, transmission output shaft rotation is the same as engine rotation with transmission in forward gear. Because of reversed engine mounting position, however, a RH propeller is required, if engine is LH (CCW) rotation; or a LH rotation propeller is required, if engine is RH (CW) rotation.

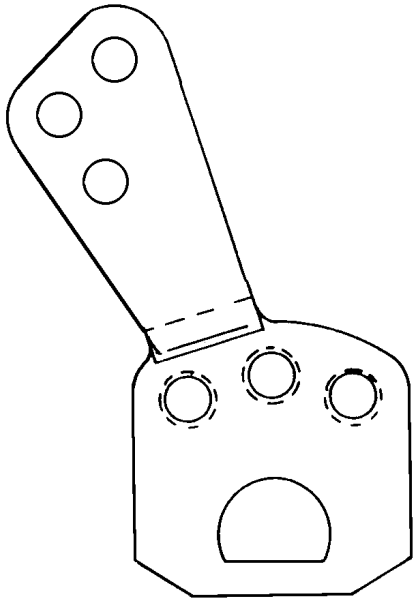
1. DO NOT start or crank engine without fluid in transmission.
2. Use only recommended fluid in transmission.
3. Except in an emergency, never shift transmission at engine speeds above 1000 RPM.
4. Free wheeling of one propeller (in a twin engine boat), at trolling speeds, will not cause damage to the transmission; however, boat operation above trolling speed should be avoided. Be sure proper fluid level exists before free wheeling propeller.
5. DO NOT paint shift lever poppet ball and spring. An accumulation of paint here will prevent proper action of the detent.
6. Always replace oil cooler and hoses after a transmission failure or prior to installing a new or rebuilt transmission. Metallic particles from a failure tend to collect in the cooler and hoses and will gradually flow back into the fluid system and damage transmission.
7. Always use specified oil cooler, hoses and fittings. Hoses must be at least 13/32 in. (10.5 mm) I.D. Oil cooler, hoses and fittings must be sufficient size to maintain transmission fluid (in sump) at 140-190°F (60-88°C).

Propeller

Propeller rotation is described when observed from the rear of the boat (stern) looking forward (bow end). The term “left-hand” (LH) refers to rotation in the counterclockwise (CCW) direction. The term “right-hand” (RH) refers to rotation in the clockwise (CW) direction. A LH propeller will move the boat forward when rotated counterclockwise. A RH propeller will move the boat forward when rotated clockwise. Propeller rotation is not necessarily the same as engine rotation.

Transmission Shift Lever

The lever has three holes as illustrated following.



71304

Shift Cable Adjustment

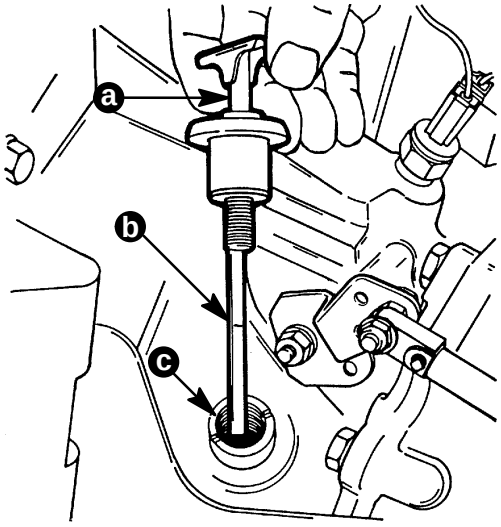
Refer to Section 2E - “MIE Models - Velvet Drive Transmissions.”

Checking Transmission Fluid Level

IMPORTANT: Use only specified transmission fluid (see “Specifications”).

Check transmission fluid before starting engine each day, as follows:

1. Remove dipstick. Check fluid level as indicated on dipstick. Fluid level may be somewhat over full mark, as some of the fluid from transmission fluid cooler and hoses may have drained back into transmission. If low, add specified transmission fluid to bring level up to full mark on dipstick.



72526

a - Dipstick
b - Full Mark
c - Dipstick Tube

IMPORTANT: To accurately check fluid level, engine must be run at 1500 RPM for 2 minutes immediately prior to checking level.

2. Start engine and run at 1500 RPM for 2 minutes to fill all hydraulic circuits.

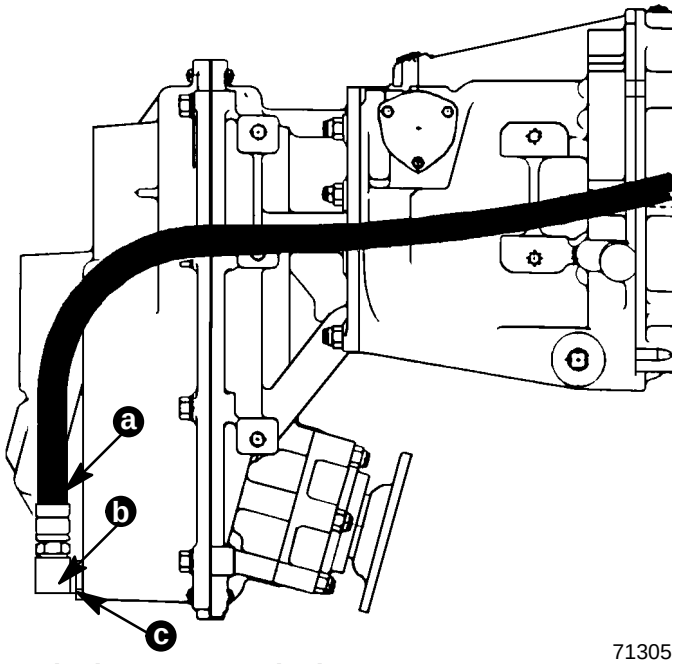
IMPORTANT: Be sure to push dipstick all the way down into dipstick tube when checking fluid level.

3. Stop engine and quickly check fluid level. Add transmission fluid, if necessary, to bring level up to full mark on dipstick.
4. Reinstall dipstick.
5. If transmission fluid level was extremely low, carefully check transmission, fluid cooler and hoses for leaks.

Changing Transmission Fluid

Draining Transmission

1. Clean area around cooler hose shown and proceed as follows:
   a. Disconnect hose from elbow fitting.
   b. Remove elbow fitting from bushing.
   c. Drain oil from transmission, cooler, and cooler lines into a suitable container.



71305

Typical MIE Transmission

a - Hose
b - Elbow Fitting
c - Bushing

2. Check oil for the following foreign matter:
   - **Metal Particles -** A few small particles are normal. Larger metal chips are an early sign of transmission failure which may mean transmission should be disassembled and inspected for internal damage.
   - **Rubber Particles -** Indication of cooler hose wear. Hoses should be inspected for cracks or fraying. Replace damaged hoses.

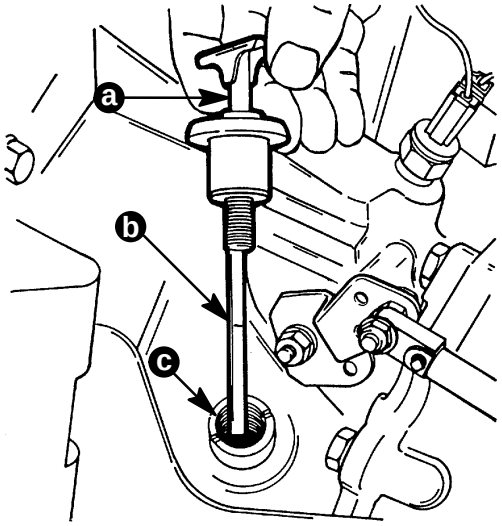
NOTE: Coat threads of bushing with Quicksilver Perfect Seal and install in transmission case if bushing came loose with elbow fitting. Torque bushing to 25 lb. ft. (34 N·m).

3. Coat elbow fitting threads with Quicksilver Perfect Seal and install in bushing. Tighten securely.
4. Reconnect hose and tighten securely.
5. Refill transmission with specified fluid. Refer to “Filling Transmission.”

Filling Transmission

IMPORTANT: Use only specified automatic transmission fluid (see “Specifications”).

1. Remove dipstick. Fill transmission with fluid, through dipstick hole, to bring up to full mark.



72526

a - Dipstick
b - Full Mark
c - Dipstick Tube

IMPORTANT: To accurately check fluid level, run engine at 1500 RPM for 2 minutes immediately prior to checking level.

2. Start engine and run at 1500 RPM for 2 minutes to fill all hydraulic circuits.

NOTE: Be sure to push dipstick all the way down into dipstick tube when checking fluid level.

3. Stop engine and quickly check fluid level. Add automatic transmission fluid, if necessary, to bring level up to full mark on dipstick.
4. Reinstall dipstick. Be sure to tighten T-handle securely.

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Removal and Installation

NOTICE

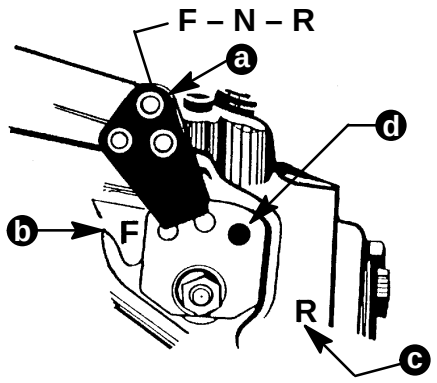
The following procedure describes removal of transmission without removing engine. If engine must be removed, refer to Section 2 (see "Table of Contents").

1. Drain transmission fluid,
2. Disconnect fluid cooler hoses.
3. Disconnect shift cable.
4. Disconnect wires from neutral start safety switch.
5. Disconnect wire from fluid temperature switch.
6. Disconnect propeller shaft coupling.
7. Remove four rear mount (to engine bed) bolts.
8. Support rear part of engine with either a hoist or by using wooden blocks under flywheel housing.
9. Remove two center transmission-to-flywheel housing attaching bolts and install two long studs.

IMPORTANT: These two long studs will help support weight of transmission during removal and installation.

10. Remove remaining transmission attaching bolts.
11. Pull transmission straight back and off engine.
12. Before installing transmission, check transmission pump indexing for correct rotation. Refer to "Pump Indexing."
13. Check transmission output shaft rolling torque. See "Specifications."
14. Apply Quicksilver Engine Coupler Spline Grease to transmission input shaft splines and engine drive plate splines.
15. If removed, install rear engine mounting brackets (to transmission) as outlined in Section 3 (see "Table of Contents"). Torque to 45 lb. ft. (61 N·m).
16. Align transmission splines with drive plate splines.
17. Slide transmission into place and secure with bolts.
18. Remove two long studs (installed in Step 9) and install remaining two bolts. Torque all bolts to 50 lb. ft. (68 N·m).
19. Relieve hoist tension and fasten rear engine mounts to engine bed. Tighten bolts securely.
20. Connect wires to neutral start safety switch.
21. Connect tan/blue wire to fluid temperature switch.
22. Connect fluid cooler hoses to transmission.
23. Connect and adjust shift cable(s) as outlined in Section 2E - "MIE Models - Velvet Drive Transmissions."

IMPORTANT: Velvet Drive Transmission Warranty is jeopardized if the shift lever poppet ball or spring is permanently removed, if the shift lever is repositioned or changed in any manner, or if remote control and shift cables do not position shift lever exactly as shown.



72601

a - Transmission Shift Lever
b - Shift Lever Must Be Over This Letter When Propelling Boat FORWARD
c - Shift Lever Must Be Over This Letter When Propelling Boat REVERSE
d - Poppet Ball Must Be Centered In Detent Hole For Each F-N-R position (Forward Gear Shown)

24. Refer to Section 2E - "MIE Models - Velvet Drive Transmissions" and check engine final alignment as outlined.
25. After engine has been properly aligned, connect propeller shaft coupler to transmission output flange. Attach couplers together with bolts, lockwashers and nuts. Torque to 50 lb. ft. (68 N·m).
26. Refill transmission with specified fluid. Refer to "Filling Transmission."
27. Check for leaks and check fluid level after first engine start-up.

Pump Indexing

Pump must be correctly indexed to correspond with engine rotation. If pump is not indexed correctly, pump will not create oil pressure and transmission will not shift. Pump housing has two arrows, each pointing in a different direction. Pump must be positioned so that the arrow (pointing in the direction that input shaft and pump will be turned by engine) is at the top of transmission.

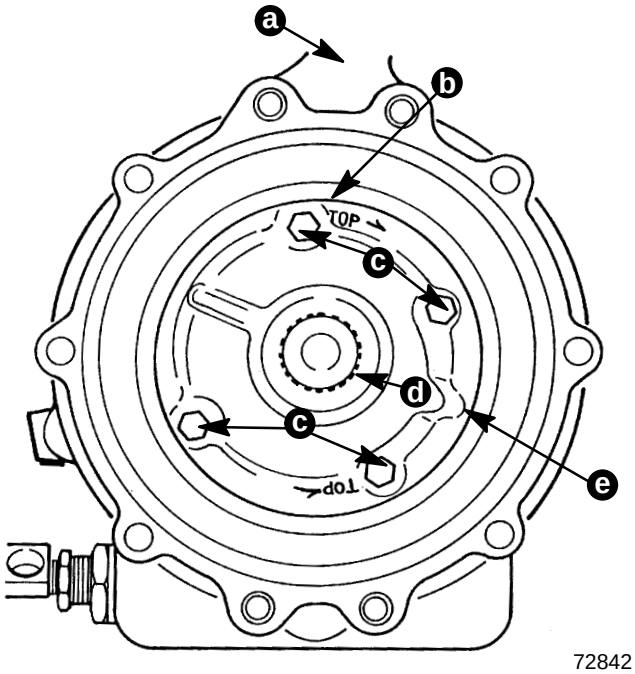
IMPORTANT: Some transmissions have letters "RH" and "LH" on pump housing. Letters DO NOT indicate engine rotation.

If pump must be reindexed, proceed as follows:

1. Remove four pump attaching bolts.
2. Loosen the pump housing. A soft tip mallet may be used to tap the fluid passage boss. Do not strike the bolt bosses.

IMPORTANT: Do not remove the pump from the shaft unless a seal protector is used to prevent the shaft splines from cutting the pump seal. Care must be taken to ensure that seal, gasket, seal and bolt bosses are kept in good condition to prevent leaks in those critical areas.

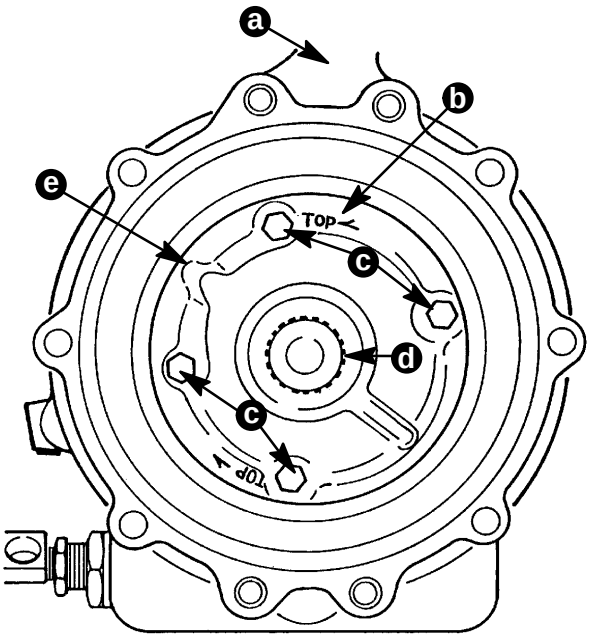
3. Make sure that pump gasket is not sticking to housing (to prevent gasket from tearing or folding) when rotating pump.
4. Rotate pump until arrow indicating the proper direction of pump rotation is near the top of transmission.
5. Reinstall four pump-to-adaptor attaching bolts and torque to 204-264 lb. in. (23-29 N·m).



72842

MIE LH (Standard) Rotation Engine

a - Top of Transmission
b - Top (Or Top RH)
c - Pump Attaching Bolts
d - Input Shaft
e - Fluid Passage Boss



72843

MIE RH (Opposite) Rotation Engine

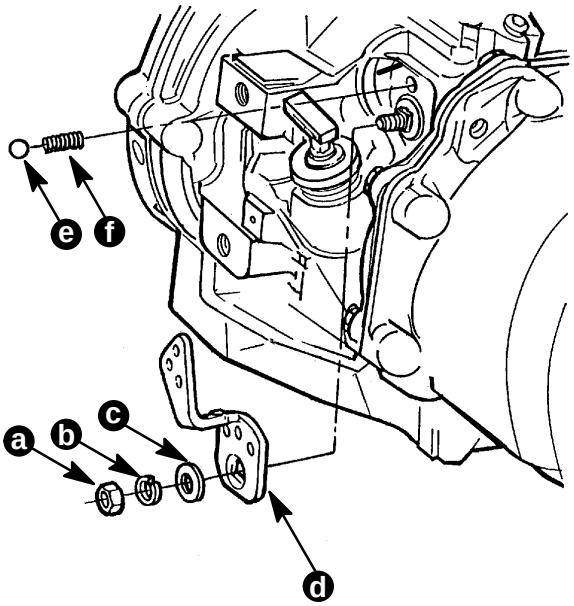
a - Top of Transmission
b - Top (Or Top RH)
c - Pump Attaching Bolts
d - Input Shaft
e - Fluid Passage Boss

Shift Lever Installation

IMPORTANT: Velvet Drive Warranty is jeopardized if the shift lever poppet spring and/or ball is permanently removed, or if the shift lever is changed in any manner, or repositioned, or if the linkage between the remote control and the transmission shift lever does not have sufficient travel in both directions.

Shift lever and related parts must be assembled as shown.

1. Lubricate poppet ball, spring, and holes in shift lever with Quicksilver 2-4-C Marine Lubricant.
2. Install poppet spring and ball. Retain ball by placing shift lever on shaft.
3. Install flat washer, lockwasher and nut on shaft.
4. Torque nut to 96-132 lb. in. (11-15 N·m).



72844

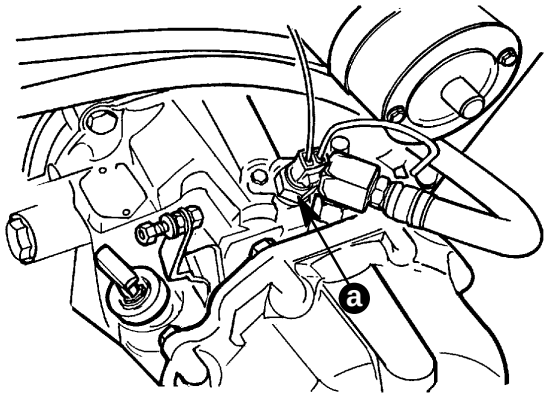
Typical Shift Lever

a - Nut
b - Lockwasher
c - Flat Washer
d - Shift Lever
e - Poppet Ball
f - Poppet Spring

5. After installation, move shift lever through forward, neutral and reverse positions. No more than finger-tip effort should be required. If valve binds, cause for binding must be found and corrected.

Pressure Test

1. Install pressure gauge.



72845

a - Main Line Pressure Tap - Models with Audio Warning System, Remove Temperature Switch; Models without Switch, Remove 3/8 In. Pipe Plug

2. With boat in water, start engine and run until normal operating temperature is reached.
3. Refer to “Specifications” (see “Table of Contents”) for pressure readings.

Transmission Repair

V-Drive

Mercury Marine does not stock or sell replacement parts for the V-drive transmission. Velvet Drive has a network of distributors throughout the world to service their product. These distributors, in turn, have a dealer network to service the transmissions. Also, service manuals (for each transmission) can be obtained from Velvet Drive.

IMPORTANT: Refer to “Special Replacement Part Information” before working on transmission.

For the location of your closest distributor or service literature, contact:

Velvet Drive Transmission
Division of Regal Beloit
Theodore Rice Boulevard
Industrial Park
New Bedford, MA 02745
Phone: (508) 995-2616

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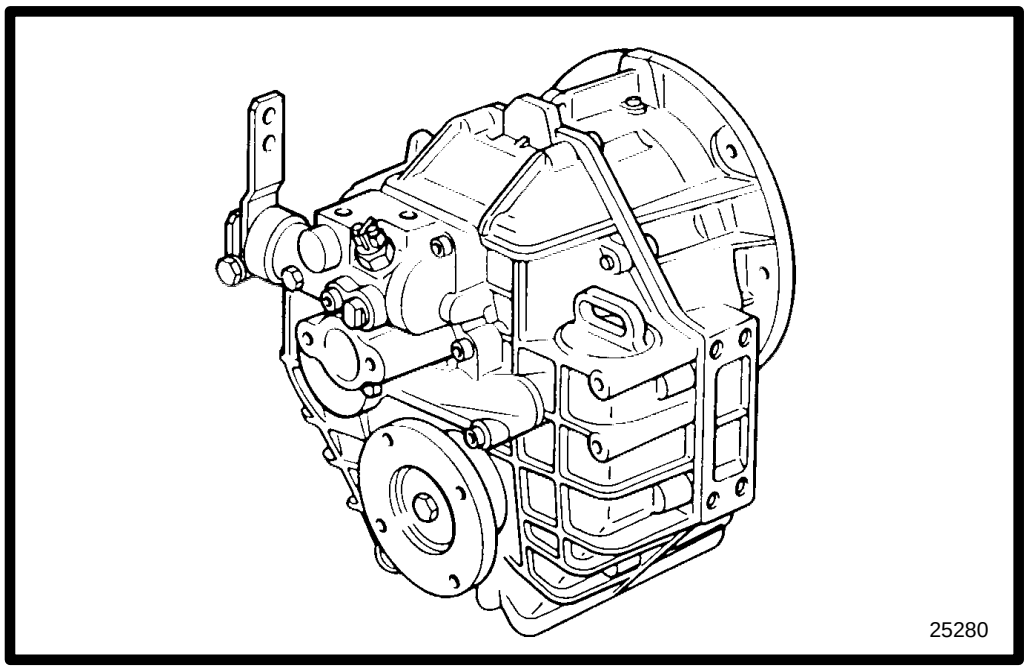
DRIVES



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C

HURTH DOWN ANGLE TRANSMISSION

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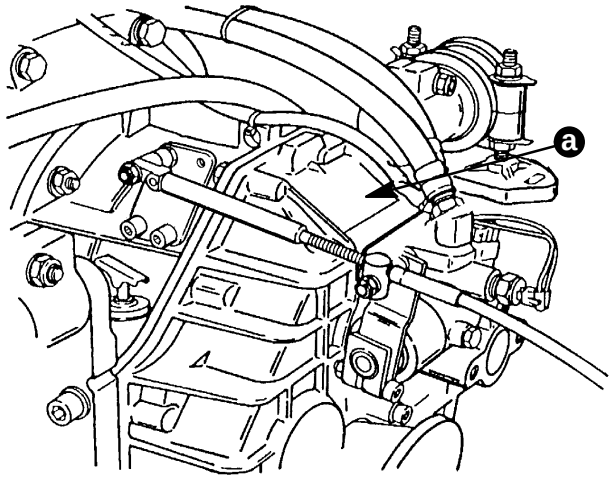
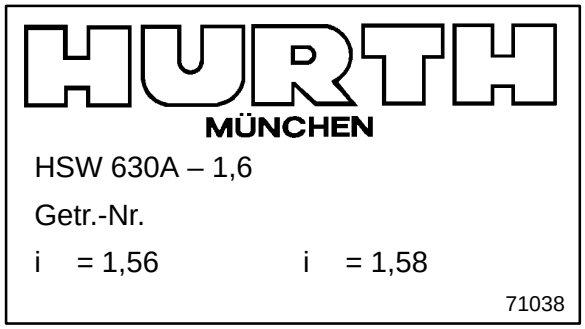
Identification

The transmission identification plate is located on the top rear of the transmission.



72957

a - Transmission Identification Plate
(Stating: Gear Ratio, Serial Number and Model)



Typical Identification Plate

Torque Specifications

Fastener Location	Lb. Ft.	N·m
Transmission Halves Bolts And Nuts	36	49
Control Block To Housing Bolts	18	25
Output Flange To Output Shaft	63	85
Mounts	50	63
Transmission To Flywheel Housing	50	68

Tools/Lubricants/Sealants

Description	Part Number
Tapered Roller Bearing Inner Race Puller	91-813950
Tapered Roller Bearing Outer Bearing Puller	91-813951
Pressure Plate Removal Tool Reversing Clutch	91-813952
Tapered Roller Bearing Inner Race Puller Plate	91-813953
Mandrel - Input Shaft Seal	91-813955
Mandrel - Output Shaft Seal	91-813956
Preload Tool- Input Shaft	91-813957
Preload Tool - Intermediate Shaft	91-816958
Quicksilver Loctite 8831	92-823089-1
Quicksilver Engine Coupler Grease	91-823089-1
Thermometer [(3/8 In, Thread 0-270°F (-18 to -132°C)]	Obtain Locally
Loctite 515 (Split-Line) Sealer	
Pressure Gauge (M10x1 Thread)	

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Specifications

Transmission Fluid Specification

Description	Part Number
ATF Dexron II-D Or Dexron lll	Obtain Locally

Capacity

Model	U.S. Qt (L)
Hurth - 630A 8° Down Angle	3-1/4 (3.0)[1]
Hurth - 800A2 8° Down Angle	5-3/4 (5.5)[1]

[1] Always use dipstick to determine exact quantity of fluid required.

Operating Specifications

Description	Specification
Shifting Pressure	312-377 PSI (2151-2599 kPa)
Operating Temperature	130-176°F (54-80°C)
Maximum Temperature	220°F (105°C)

Transmission Ratios

Transmission Model	630A			800AM	
Nominal Transmission Ratio	1.5	2.0	2.5	2.5	2.8
Transmission Ratio Shifting Position “A” (Forward Gear)	1.56	2.04	2.52	2.5	2.85
Transmission Ratio Shifting Position “B” (Reverse Gear)	1.58	2.10	2.53	2.46	2.80

General

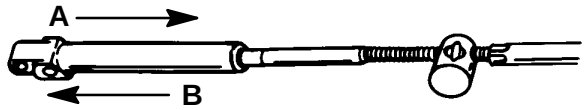
The Hurth transmission is a “full power reversing” transmission, allowing a standard (LH rotation) engine to be used for both rotations. Propeller rotation is determined by shift cable attachment at the remote control.

⚠CAUTION

Avoid severe transmission damage. ALL Hurth transmissions require standard left-hand rotation engines. NEVER connect a Hurth transmission to a right-hand rotation engine.

IMPORTANT: Transmission propeller rotation is determined by the shift cable installation in the remote control.

- RIGHT-HAND PROPELLER ROTATION - Control cable will have to be installed in remote control so that cable end will move in direction (A) when shift handle is placed in the forward position.
- LEFT-HAND PROPELLER ROTATION - Control cable will have to be installed in remote control so that cable end will move in direction (B) when shift handle is placed in the forward position.



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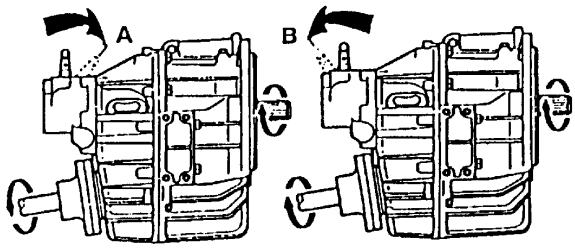


72709

Shifting Lever in Position	Propeller Rotation	Propeller
A	Opposite to Engine Rotation	Right Hand (RH)
B	Same as Engine Rotation	Left-Hand (LH)

Shift Cable Installation and Adjustment

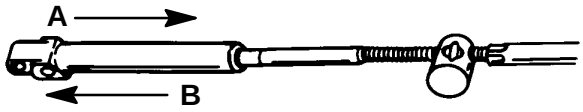
IMPORTANT: When installing shift cables, be sure that cables are routed in such a way as to avoid sharp bends and/or contact with moving parts. DO NOT fasten any items to shift cables.

IMPORTANT: These Hurth transmissions are full reversing transmissions. Direction of output/ propeller rotation is determined by hookup of shift cable at remote control.

NOTE: *Shift cable must be hooked up to remote control before starting installation and adjustment procedures.*

For Standard Left-Hand Rotation – shift cable hookup at remote control must result in shift cable end guide moving in direction (B), when remote control handle is placed in forward position.

For Right-Hand Rotation – shift cable hookup at remote control must result in shift cable end guide moving in direction (A), when remote control handle is placed in forward position.



23242

1. Be certain anchor stud is installed in the hole marked for transmission (Model 630A, or 800AM, respectively).

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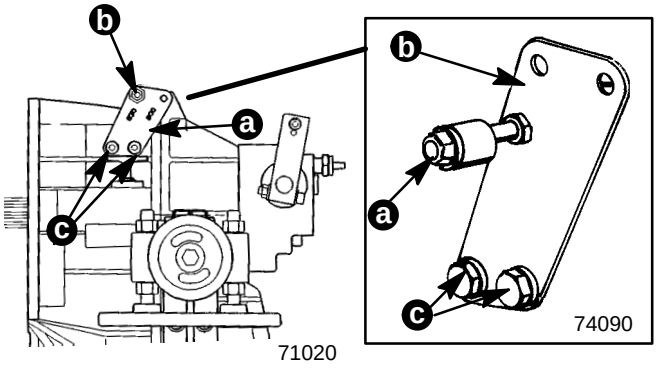
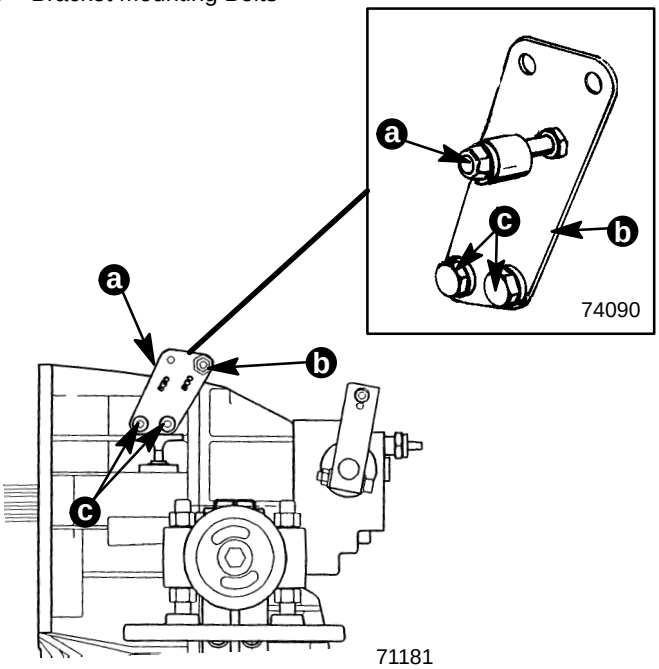
⚠ WARNING

Avoid serious personal injury or property damage caused by improper shifting. Anchor stud for shift cable must be installed in the correct hole.



Shift Cable Bracket - Anchor Stud Position Shown for 630A Transmission

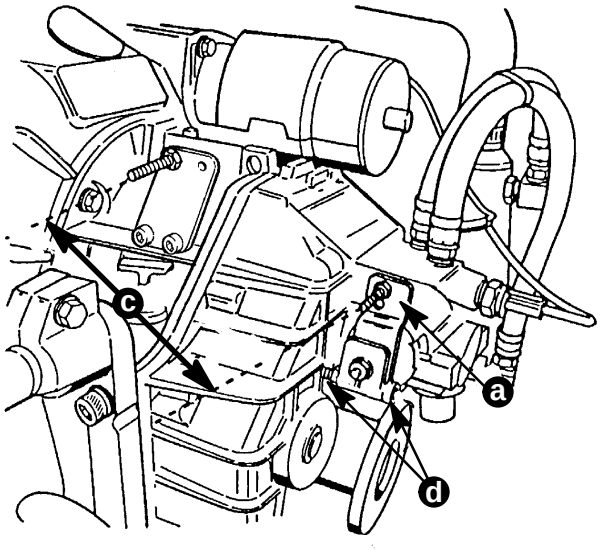
a - Shift Cable Bracket
b - Anchor Stud Location
c - Bracket Mounting Bolts

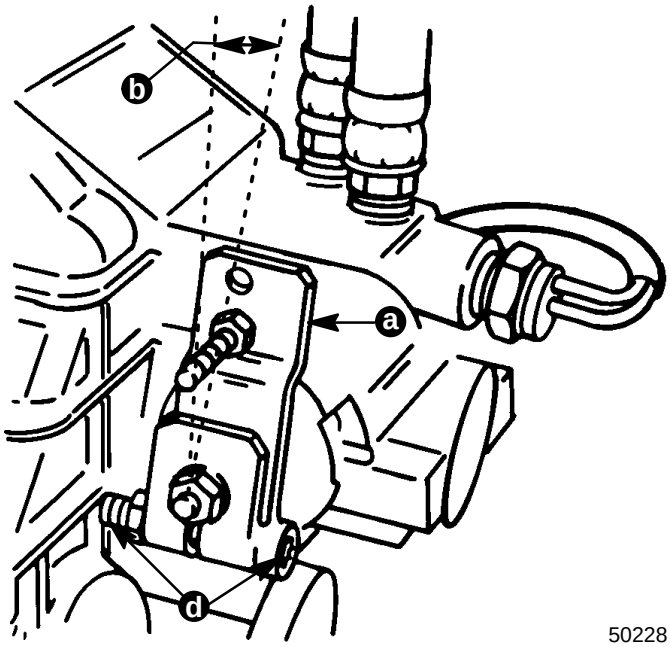


Shift Cable Bracket - Anchor Stud Position Shown for 800AM or 800 A2 Transmission

a - Shift Cable Bracket
b - Anchor Stud Location
c - Bracket Mounting Bolts

IMPORTANT: Check that shift lever is positioned approximately 10 degrees aft of vertical when in the neutral detent position and that the distance (c) between studs in the following is set at 7-1/8 in. (318 mm). If necessary, loosen clamping bolt and position lever so that dimension (c) is as shown when in the neutral detent position and retighten bolt.





a - Shift Lever
b - Lever In Neutral Detent, Must Be Approximately 10 Degrees Of Vertical
c - Dimension Between Studs - 7-1/8 In. (318 mm)
d - Clamping Bolt

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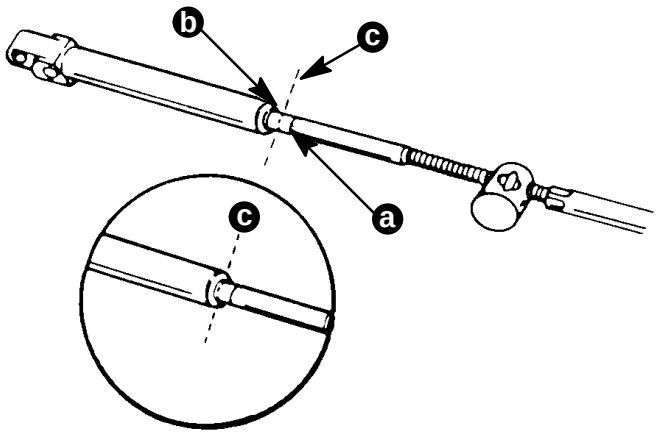
2. Place remote control shift lever, and transmission shift lever, in neutral position.

3. Remove nuts and washers from shift cable attaching studs.

4. Locate center of remote control and control shift cable play (backlash), as follows:
   a. Check that remote control is in neutral position.
   b. Push in on control cable end with enough pressure to remove play, and mark position (a) on tube.
   c. Pull out on control cable end with enough effort to remove play, and mark position (b) on tube.
   d. Measure distance between marks (a) and (b), and mark position (c), halfway between marks (a) and (b).



72603

5. Center cable-end play, then adjust cable barrel to align holes in barrel and in cable end guide with attaching points on transmission.

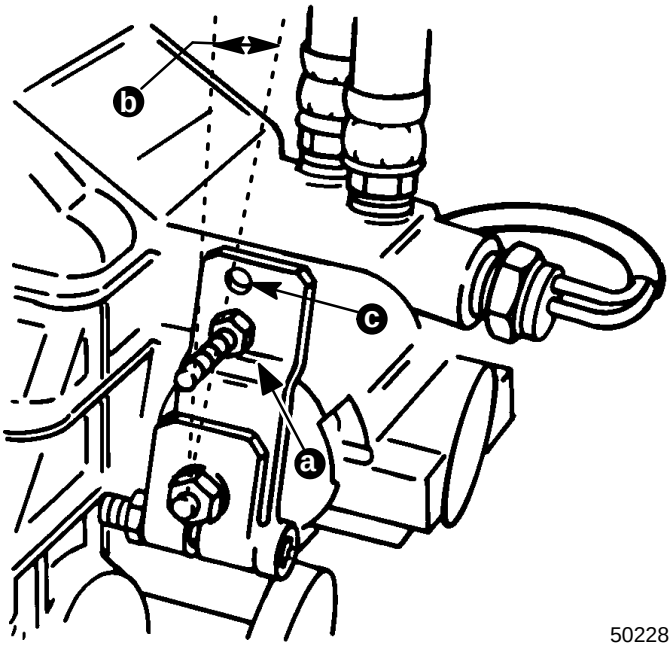
6. Temporarily install shift cable. Do not secure at this time.

IMPORTANT: Transmission is fully in gear when shift lever comes to a stop, in either direction.

7. Place remote control shift lever in forward gear position. Check to ensure transmission is fully in gear, as follows:
   a. Hold shift lever in position.
   b. Carefully slide shift cable off of anchor points.
   c. Attempt to move shift lever further.

8. Place remote control shift lever in reverse gear position and again check to ensure transmission is fully in gear as follows:
   a. Hold shift lever in position.
   b. Carefully slide shift cable off of anchor points.
   c. Attempt to move shift lever further.

9. If transmission shift lever will position properly in one gear, but not in the other, recheck shift cable adjustment. If transmission shift lever will not position properly in both gears, move transmission shift lever stud, from top hole in shift lever to bottom hole, and recheck for proper positioning. If proper positioning is still not obtained, remote control does not provide sufficient shift cable travel and must be replaced.



50228

a - Shift Lever Stud (In Bottom Hole, If Required)
b - Lever In Neutral Position, Must Be Approximately 10 Degrees Aft Of Vertical
c - Shift Lever Top Hole

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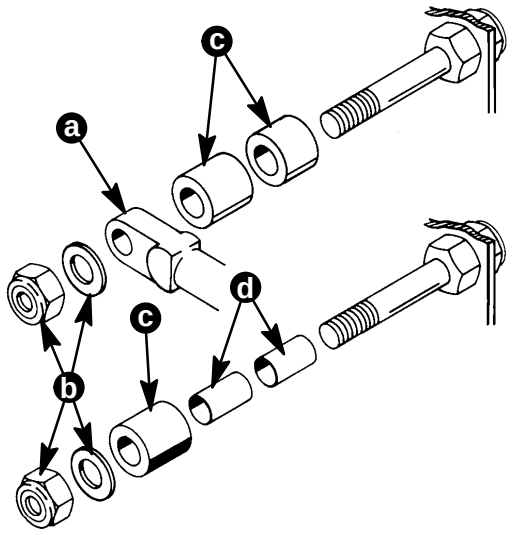
10. Install nut and washer to cable end guide stud. Tighten until snug, then back off one full turn.

11. Install nut and washer to cable barrel stud. Tighten until they bottom out. Tighten securely, but do not over- tighten.



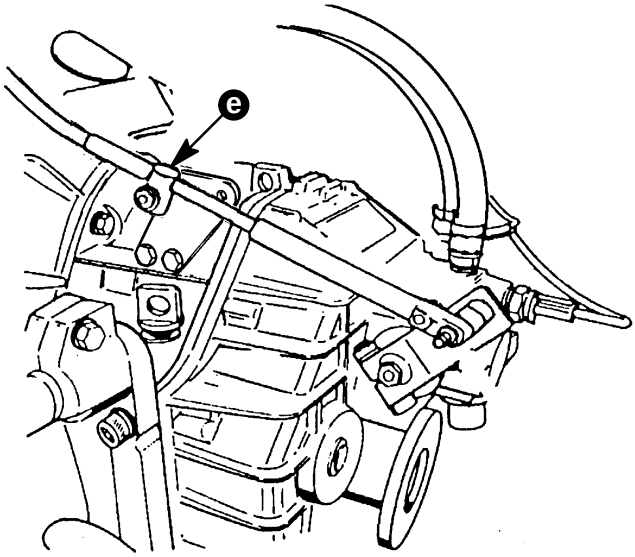
50229

a - Cable End Guide
b - Locknut and Washer (Tighten Until Bottoms Out, Then Back Off 1/2 Turn)
c - Spacer
d - Bushings
e - Cable Barrel

12. Once shift cable adjustment is correct, secure shift cable(s) with hardware as shown, referring to appropriate configuration following:

NOTE: *To change cable approach direction on single or dual station installations, only the spacer/bushings have to be switched to the opposite stud (the studs are identical).*

SINGLE CABLE - FORWARD ENTRY



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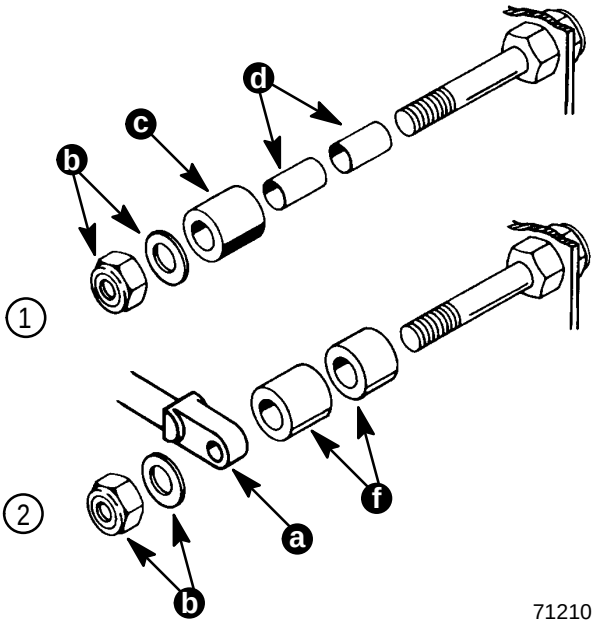

71210

1 - Cable Barrel Stud
2 - Cable End Guide Stud

a - Cable End Guide
b - Locknut and Washer (Tighten Until Bottoms Out, Then Back Off 1/2 Turn)
c - Spacer (Fits Over Bushings)
d - Bushing
e - Cable Barrel
f - Spacers (Fits Over Stud)

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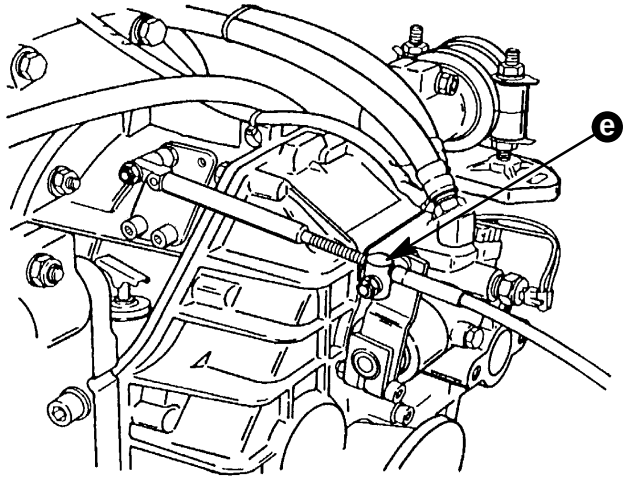
SINGLE CABLE - REAR ENTRY



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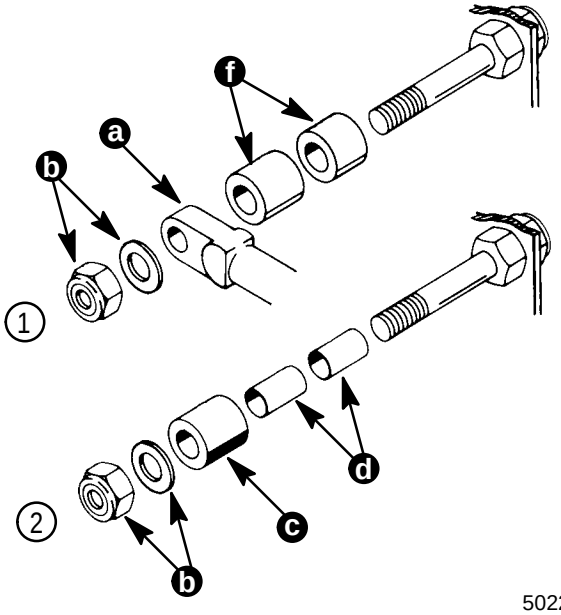
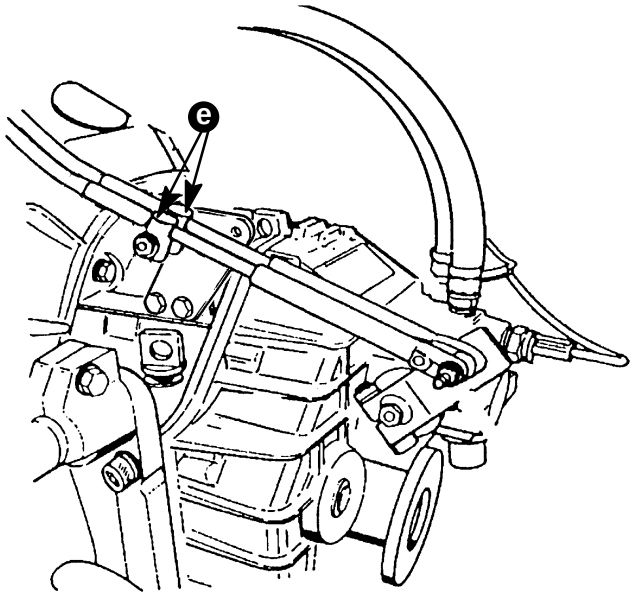


50229

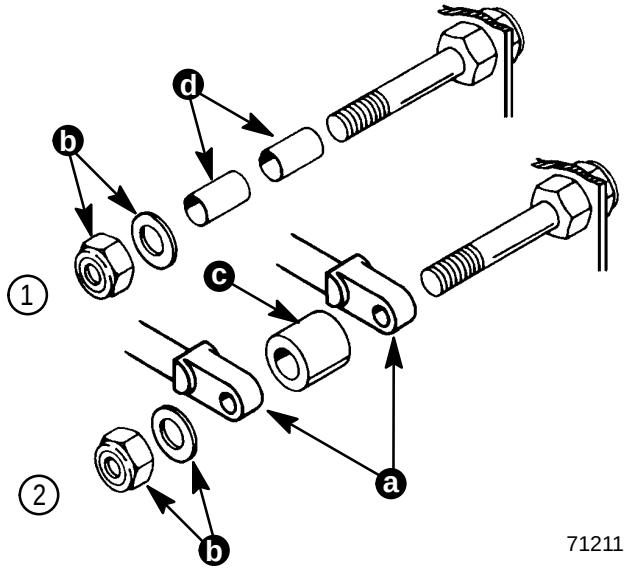
1 - Cable Barrel Stud
2 - Cable End Guide Stud

a - Cable End Guide
b - Locknut and Washer (Tighten Until Bottoms Out, Then Back Off 1/2 Turn)
c - Spacer (Fits Over Bushings)
d - Bushing
e - Cable Barrel

DUAL CABLE - FORWARD ENTRY



72956



71211

1 - Cable Barrel Stud
2 - Cable End Guide Stud

a - Cable End Guide
b - Locknut and Washer (Tighten Until Bottoms Out, Then Back Off 1/2 Turn)
c - Spacer (Fits Over Bushings)
d - Bushing
e - Cable Barrel
f - Spacers (Fits Over Stud)

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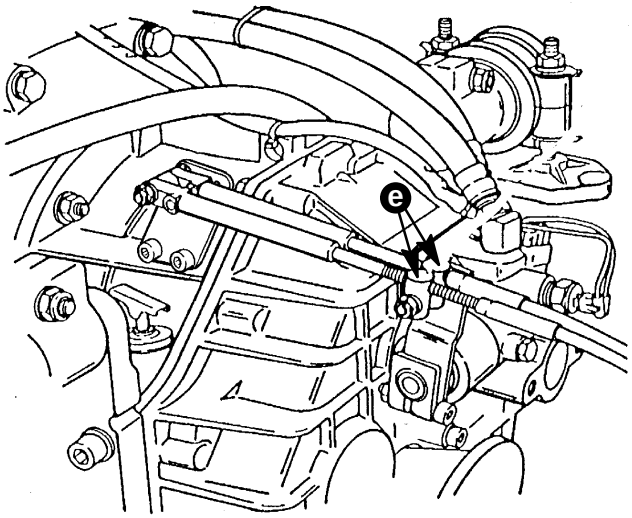
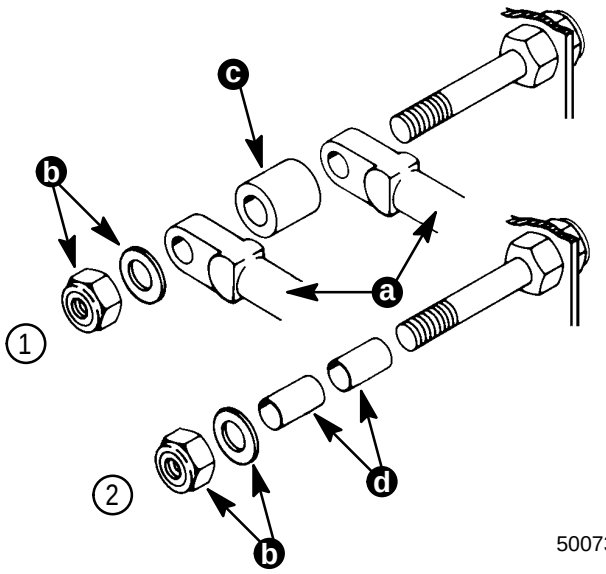
DUAL CABLE - REAR ENTRY



72960



50073

1 - Cable Barrel Stud
2 - Cable End Guide Stud

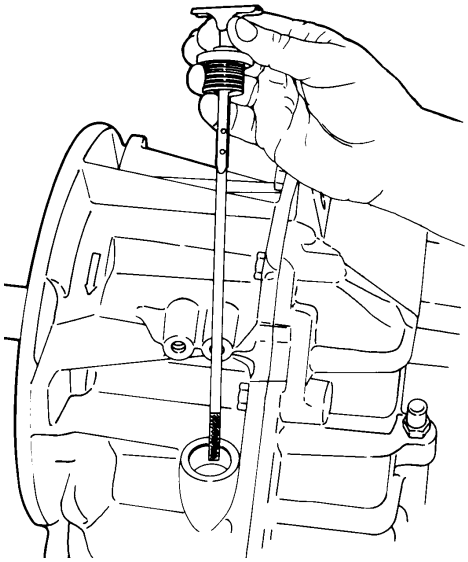
a - Cable End Guide
b - Locknut and Washer (Tighten Until Bottoms Out, Then Back Off 1/2 Turn)
c - Spacer (Fits Over Bushings)
d - Bushing
e - Cable Barrel
f - Spacers (Fits Over Stud)

Checking Transmission Fluid Level

IMPORTANT: Use only specified transmission fluid (see "Specifications").

Check transmission fluid before starting engine each day, as follows:

1. Remove dipstick. Check fluid level as indicated on dipstick. Fluid level may be somewhat over full mark, as some of the fluid from transmission fluid cooler and hoses may have drained back into transmission. If low, add transmission fluid to bring level up to full mark on dipstick.



27661

Typical Hurth Transmission Shown

IMPORTANT: To accurately check fluid level, engine must be run at 1500 RPM for two minutes immediately prior to checking level.

2. Start engine and run at 1500 RPM for two minutes to fill all hydraulic circuits.

IMPORTANT: Be sure to push dipstick all the way down into dipstick tube when checking fluid level.

3. Stop engine and quickly check fluid level. Add automatic transmission fluid, if necessary, to bring level up to full mark on dipstick. (Refer to "Filling Transmission," following.)

4. Reinstall dipstick.

5. If transmission fluid level was extremely low, carefully check transmission, fluid cooler and hoses for leaks.

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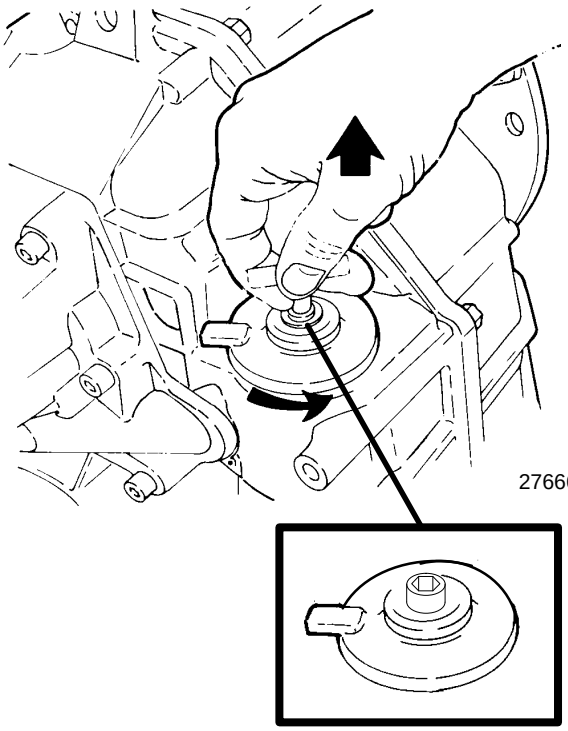
Draining Transmission

1. Clean the exterior of transmission before disassembly.

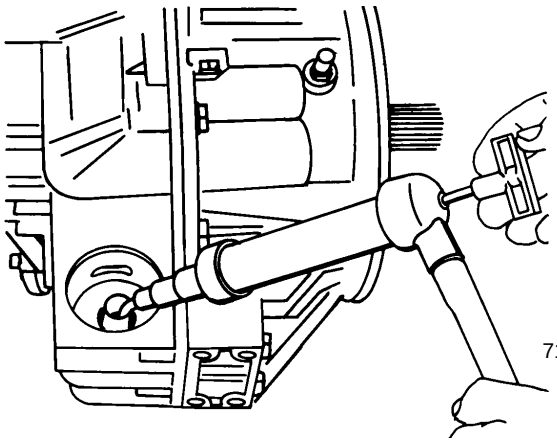
NOTE: *Later model Hurth transmissions have a allen head socket screw on oil filter cover.*

2. Remove oil filter from housing by turning (counterclockwise) and pulling at the same time.



a - Set Screw (Later Models)

3. Push hose of suction pump through suction pipe and down to the bottom of the housing. Pump fluid from housing.

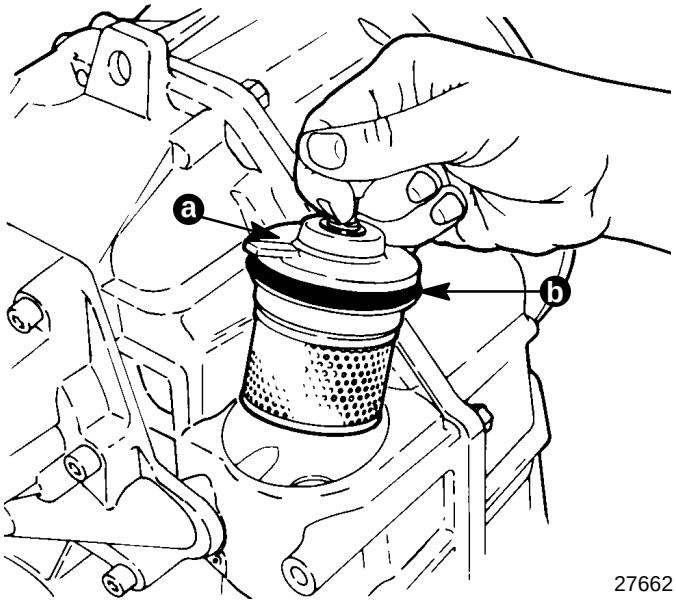


Filling Transmission

IMPORTANT: Use only Automatic Transmission Fluid (ATF) as recommended in "Specifications."

1. Fill transmission to proper level, through oil filter cavity. (Refer to "Capacity.")

2. Install filter as follows:
   a. Coat O-ring on filter cover with transmission fluid.



a - Filter Cover
b - O-Ring

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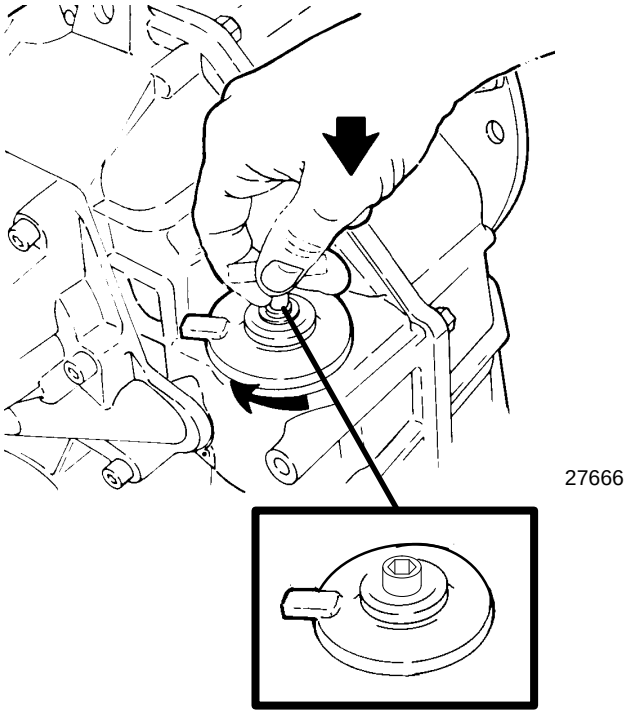
⚠CAUTION

Transmission fluid filter and cover must be properly seated to avoid fluid foaming and/or loss of fluid, thus resulting in decreased efficiency and/or damage to transmission.

b. Push down until cover is fully seated (top of cover flush with housing), then turn T-handle or tighten allen head screw clockwise until tight.

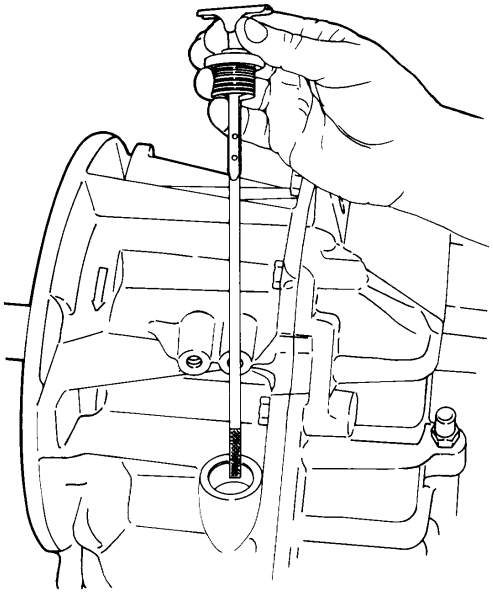


27666

a - Set Screw (Later Models)

3. Start engine and run for two minutes to fill system with fluid.

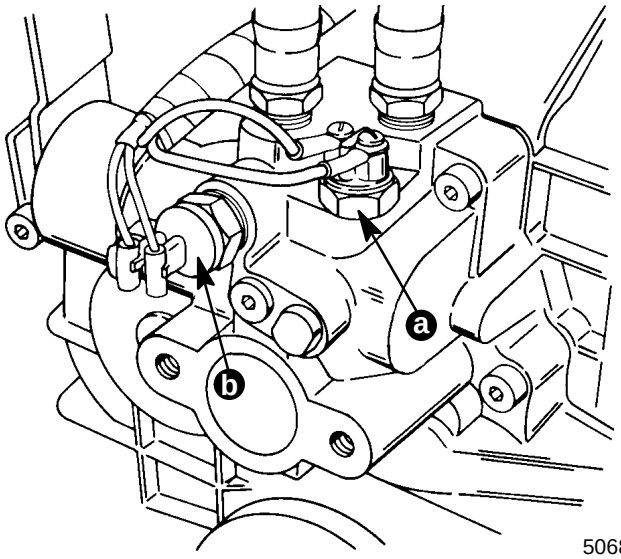
4. Stop engine and check fluid level. Fluid should be between min. and max. lines on dipstick.



27661

Transmission Removal

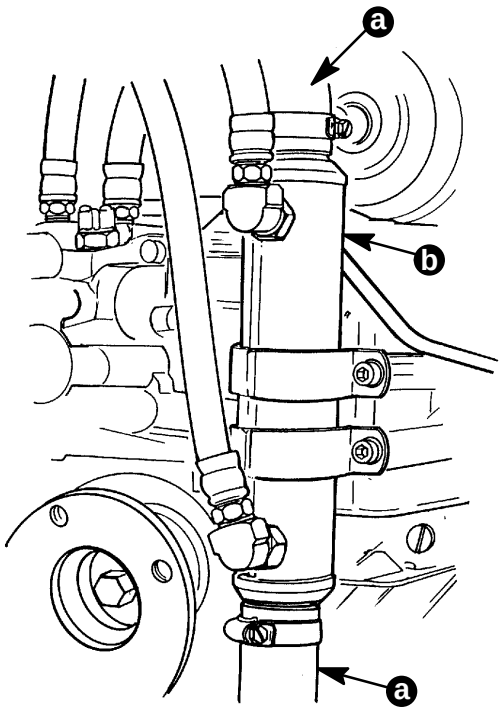
1. Disconnect wires from neutral safety switch and audio warning temperature switch.



50686

a - Neutral Safety Switch
b - Audio Warning Temperature Switch

2. Disconnect seawater hoses from transmission fluid cooler.



72721

a - Seawater Hoses
b - Transmission Fluid Cooler

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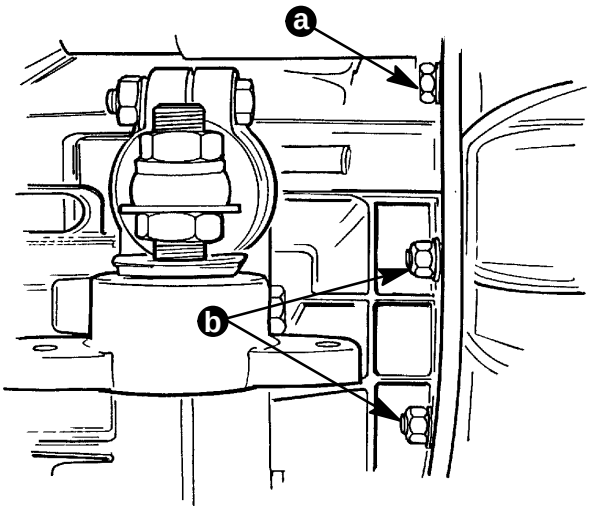
3. Remove bolts and locknuts and remove transmission.

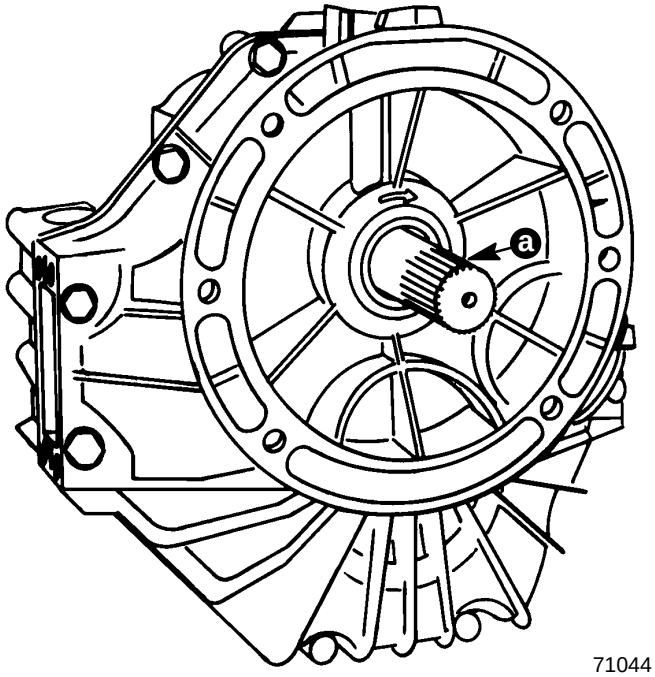


72720

a - Bolts (2), One On Each Side
b - Locknuts (4), Two On Each Side

Transmission Installation

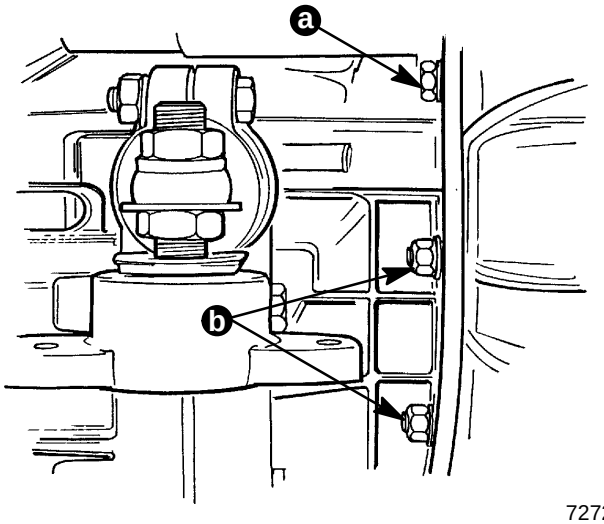
1. Coat splines on input shaft with Quicksilver Engine Coupler Spline Grease.



71044

a - Input Shaft

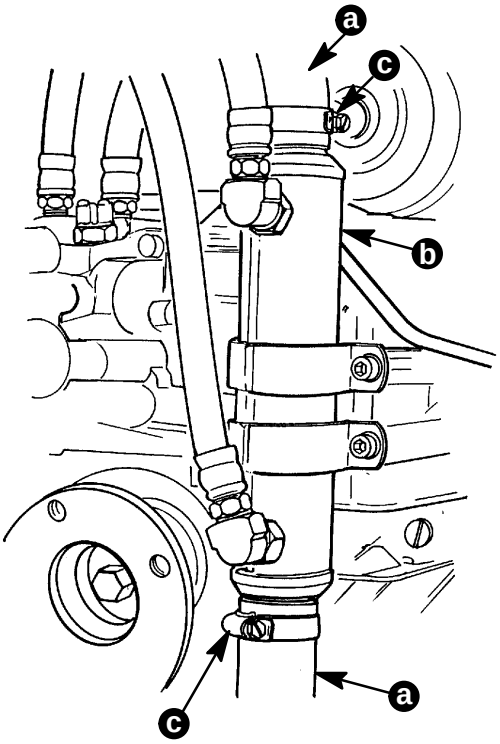
2. Install transmission on flywheel housing and secure with hardware shown. Torque fasteners to 50 lb. ft. (68 N·m).



72720

a - Bolts (2), One On Each Side
b - Locknuts (4), Two On Each Side

3. Connect seawater hoses to transmission fluid cooler and tighten hose clamps securely.



72721

a - Seawater Hoses
b - Transmission Fluid Cooler
c - Clamps

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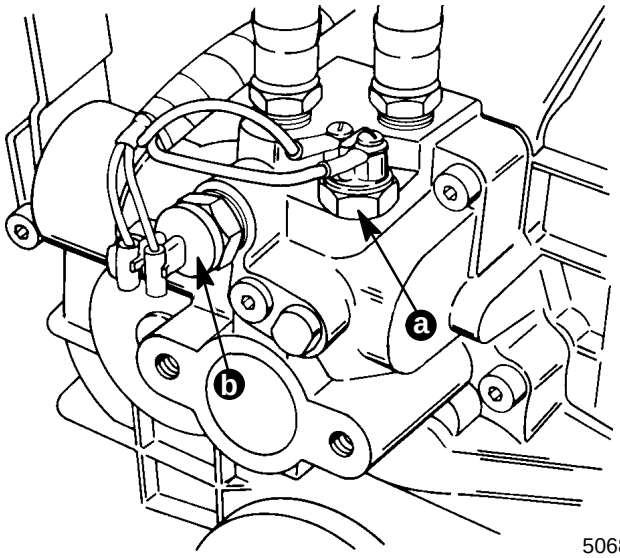
4. Connect wires to neutral safety switch and to audio warning temperature switch. Coat connections on neutral safety switch with Quicksilver Liquid Neoprene.



50686

a - Neutral Safety Switch
b - Audio Warning Temperature Switch

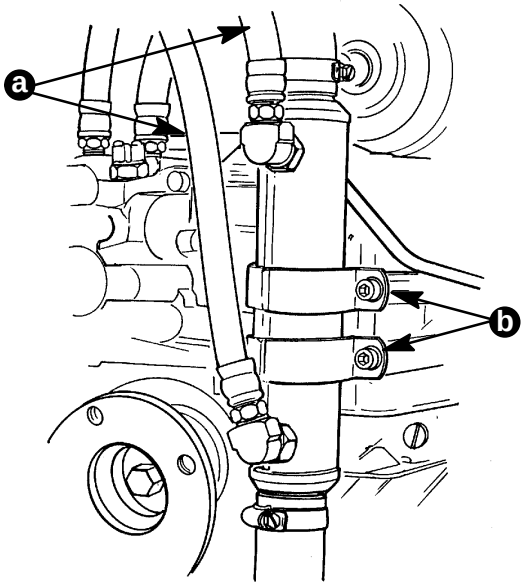
Transmission Repair

Disassembly

IMPORTANT: Ensure work area is clean before disassembly is started. Be sure to use lint free cloths when cleaning and/or handling parts.

TRANSMISSION FLUID COOLER

1. Disconnect transmission fluid hoses from cooler and remove clamps that secure cooler to housing.

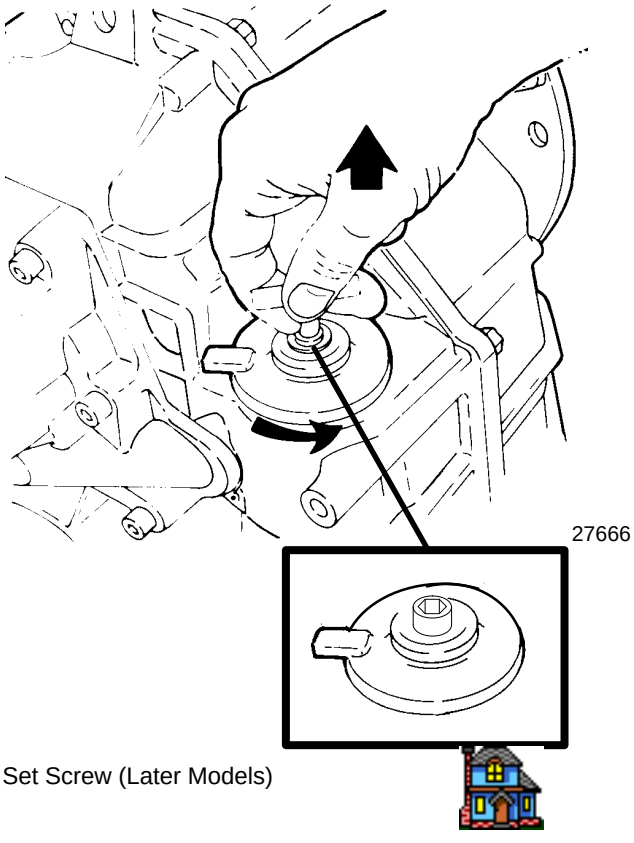


72721

a - Transmission Fluid Hoses
b - Clamps

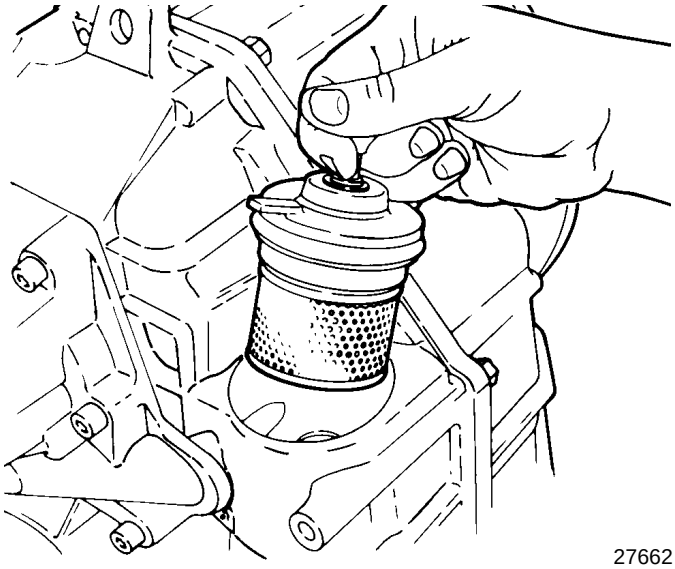
OIL FILTER AND DIPSTICK

1. Remove oil filter from housing by turning T-handle or allen head screw (counterclockwise) and pulling at the same time.


27666

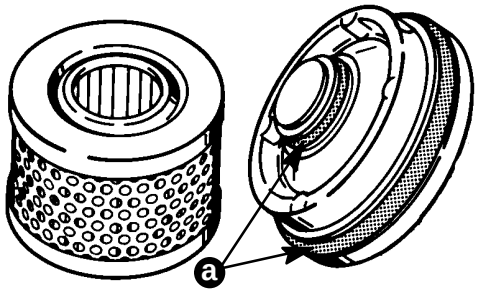
a - Set Screw (Later Models)

2. Remove cover and filter element from transmission.



27662

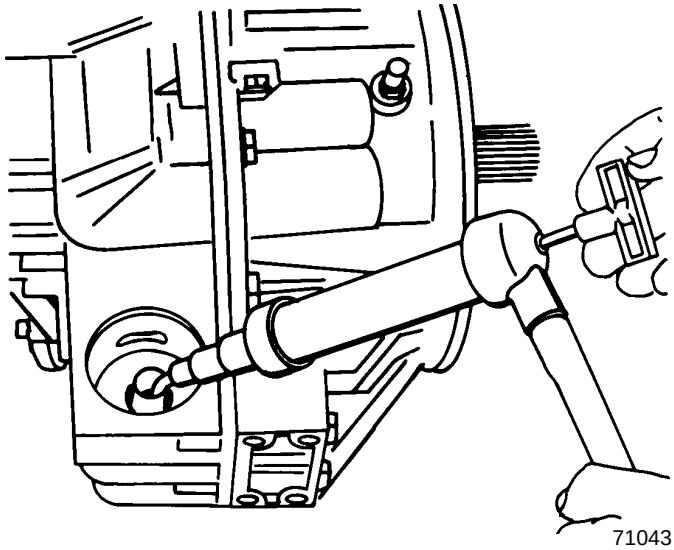
3. Remove filter element from cover and inspect O-rings for wear. Replace if necessary.



50975

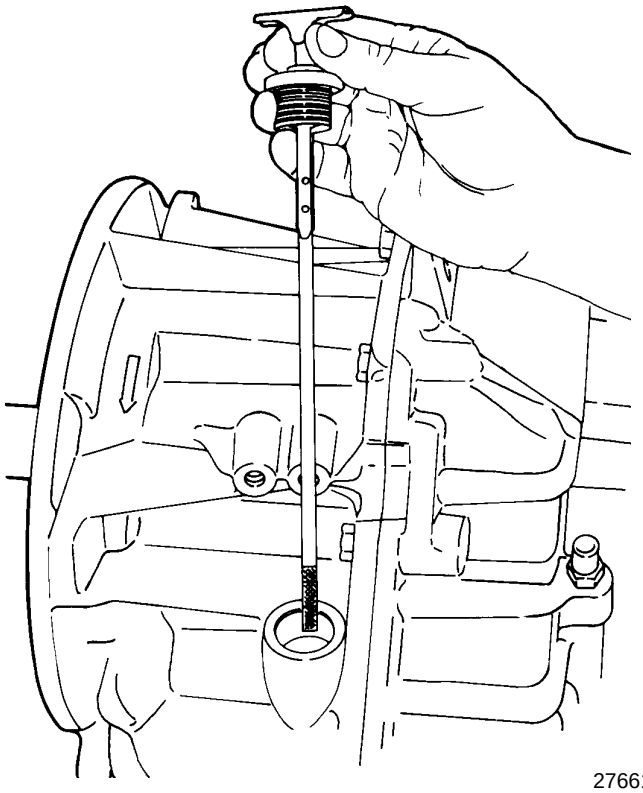
a - O-Rings

4. Push hose of suction pump through suction pipe and down to the bottom of the housing. Pump fluid from housing.



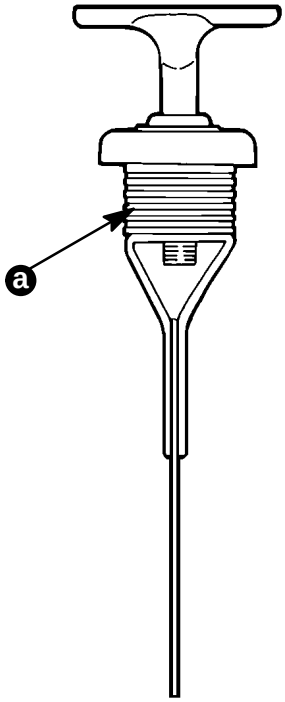
71043

5. Remove dipstick by turning (counterclockwise) and pulling at the same time.



27661

6. Inspect seal for wear and replace if necessary.



27659

a - Seal

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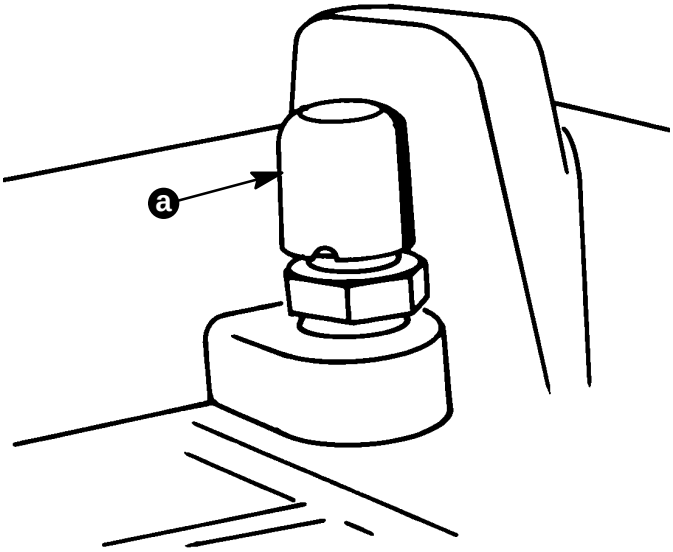
BREATHER VALVE

1. Remove breather valve. Clean with suitable cleaner, allow to dry and coat with oil.

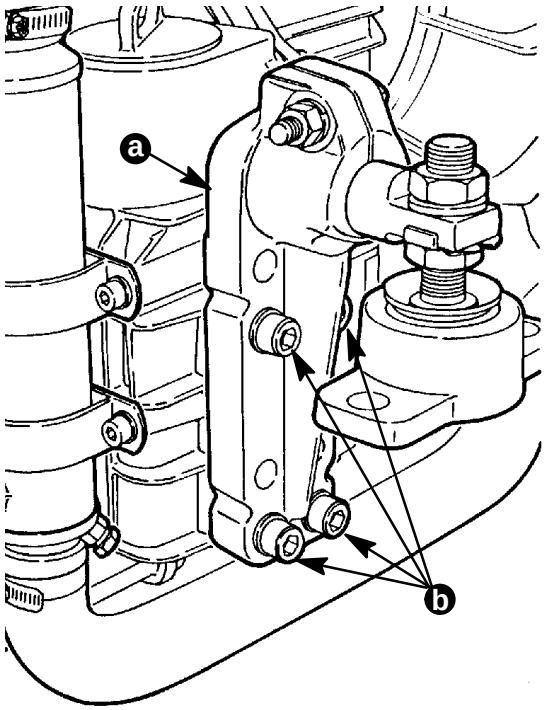


71048

a - Breather Valve

MOUNTS

1. Remove mounts from transmission housing. Inspect mounts for damage and replace if necessary.

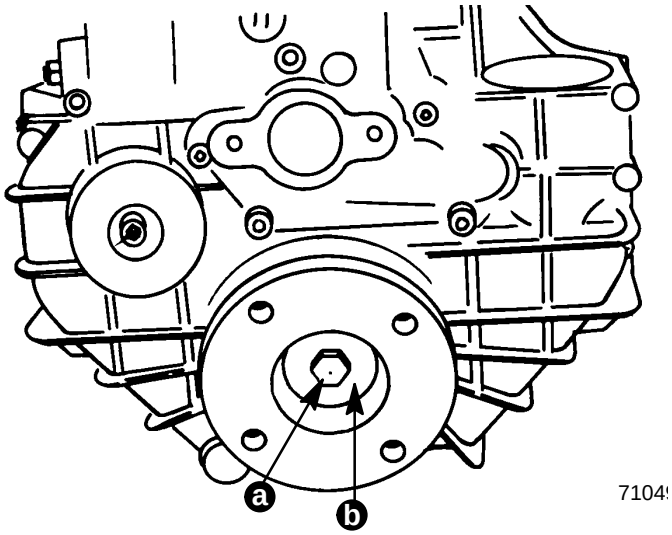


72711

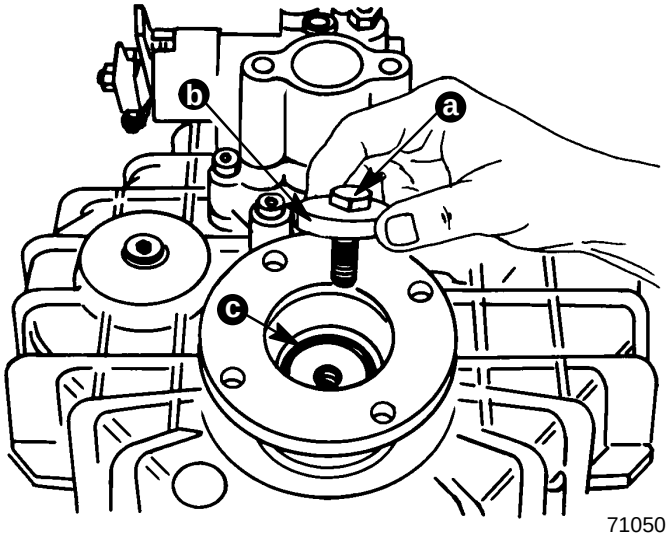
a - Transmission Mount
b - Retaining Screws (4 Total On Each Mount - One Hidden In This View)

OUTPUT FLANGE

1. Remove bolt, washer and O-ring.



7104



71050

a - Bolt
b - Washer
c - O-Ring

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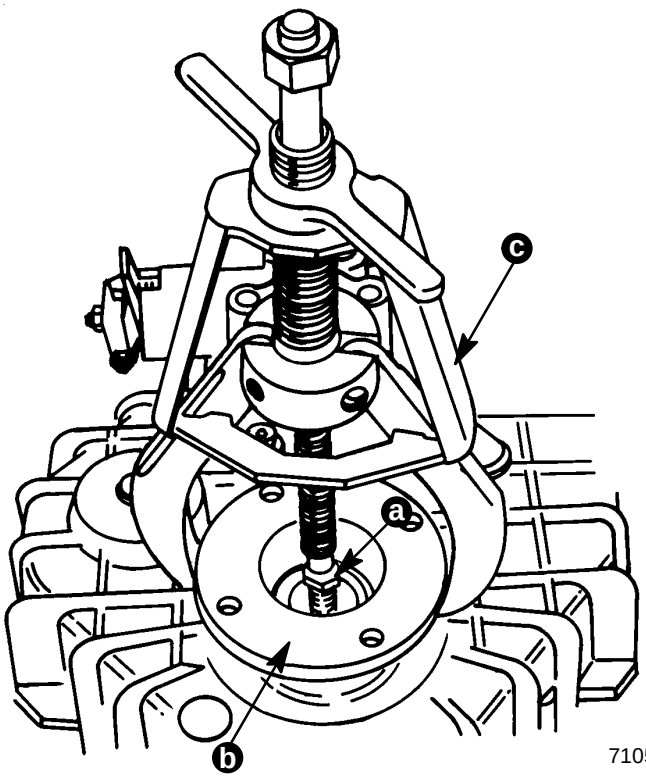
2. Reinstall bolt and remove flange using appropriate puller.



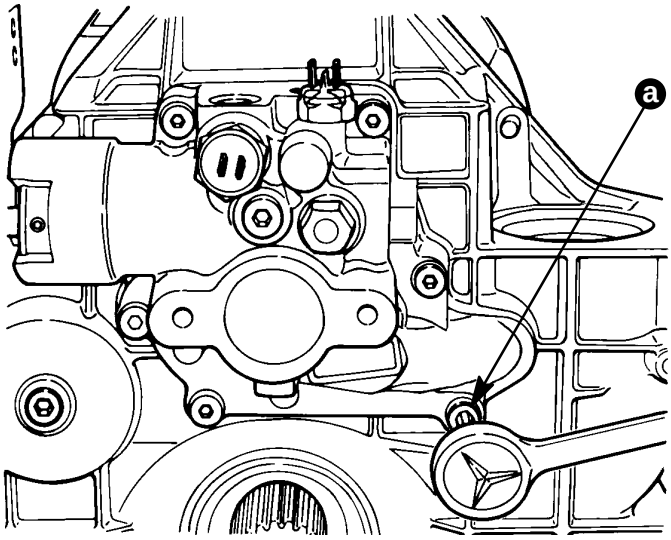
71051

71052

a - Bolt
b - Flange
c - Puller

CONTROL BLOCK

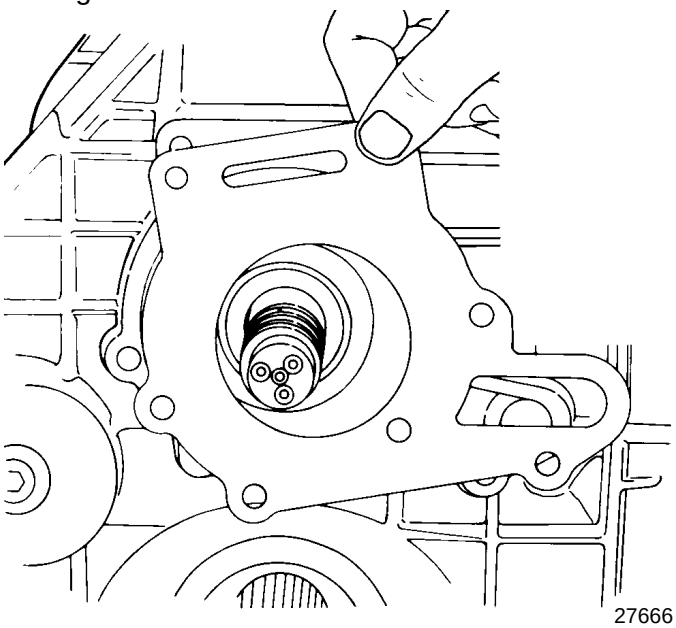
1. Remove hex head bolts.



27661

a - Hex Head Bolts (6)

2. Remove control block and gasket from housing.



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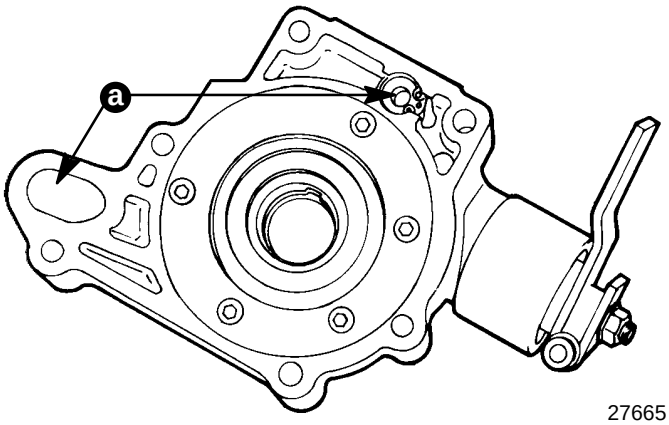
⚠CAUTION

Be careful not to allow dirt to enter control block from front side.

3. Cover openings in control block with a protective cloth.

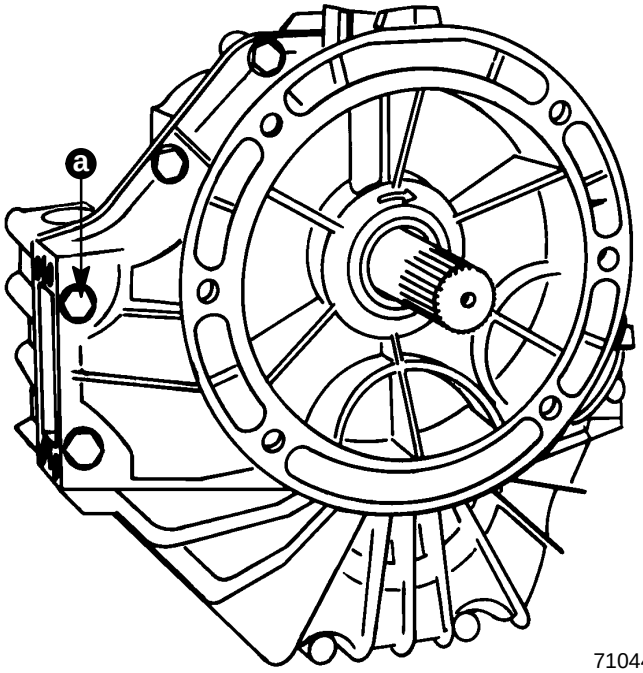


27665

a - Openings

HOUSING

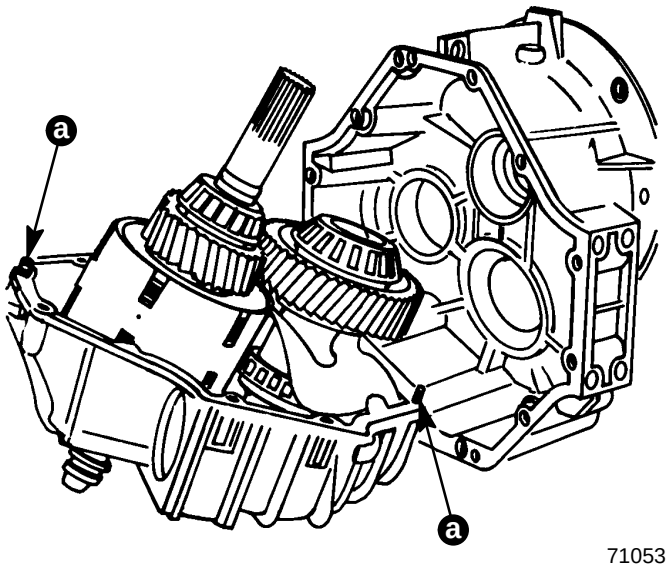
1. Remove hex head bolts from input side of housing.



71044

a - Bolts (12)

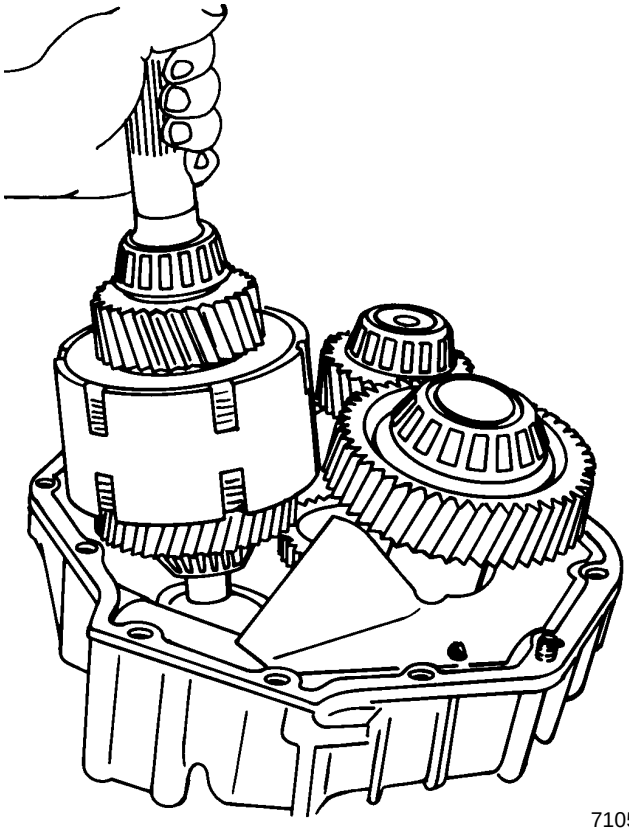
2. Remove input side of housing. Be sure to locate and save locator pins.



71053

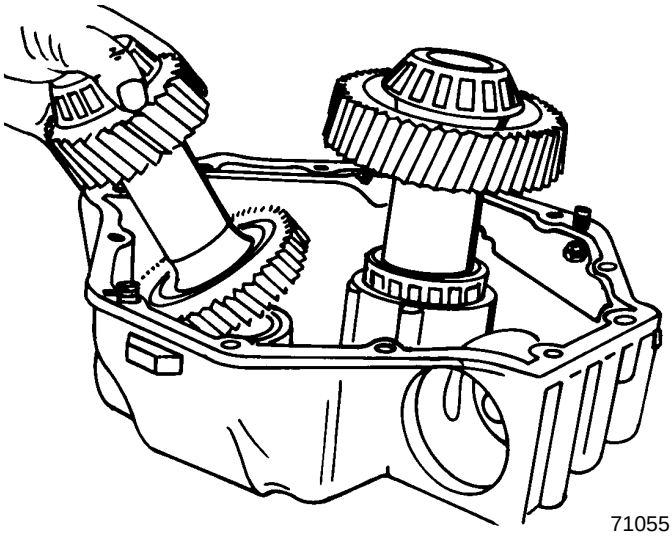
a - Locator Pins

3. Remove input shaft assembly.



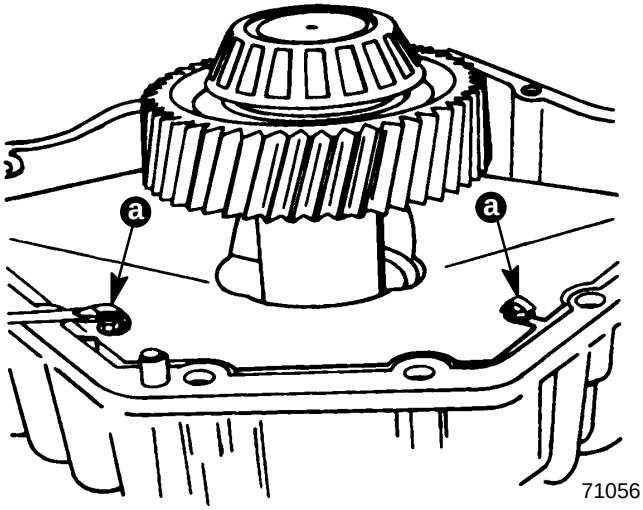
71054

4. Remove intermediate shaft assembly.

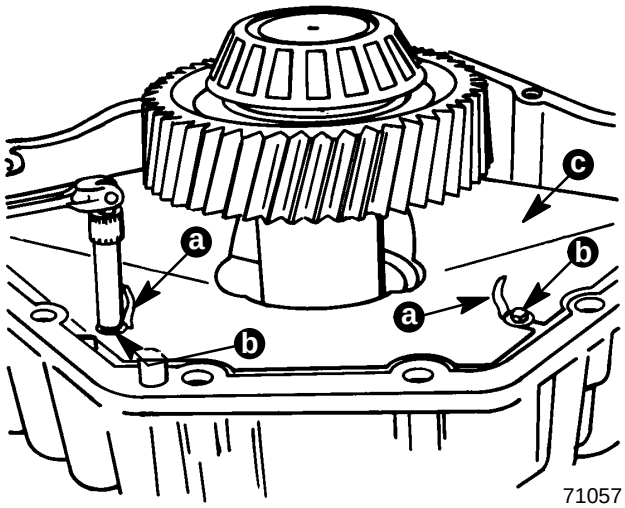


71055

5. Remove baffle plate as follows:
   a. Bend tabs up away from screws.
   b. Remove screws, then remove baffle plate.



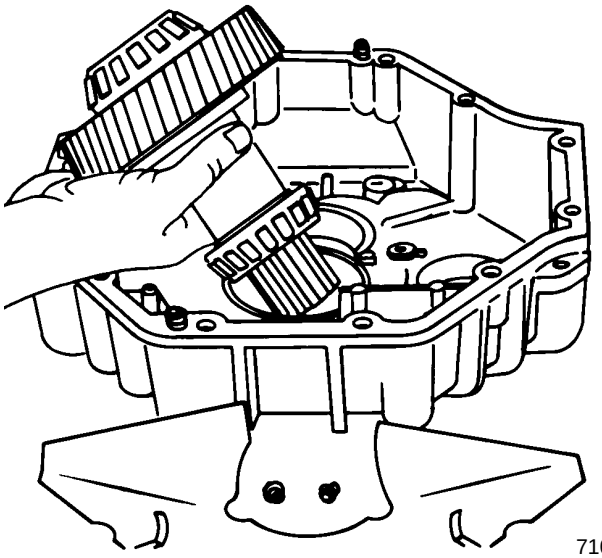
71056



71057

a - Tab
b - Screws
c - Baffle Plate

6. Remove output shaft assembly.



71058

BEARING, GEAR AND SEAL INSPECTION

1. Inspect all tapered roller bearings, the piston rings on the input shaft and all gears for wear. If damage has been found on the gearing of the intermediate or output shaft, it is ALWAYS necessary to replace the complete shaft.

When gears on the input shaft have to be replaced, the tapered roller bearings and needle bearings MUST BE replaced as well.

2. Turn gears of input shaft to check correct operation of the reversing clutch. If it is hard to turn the gears, the clutch is probably damaged.

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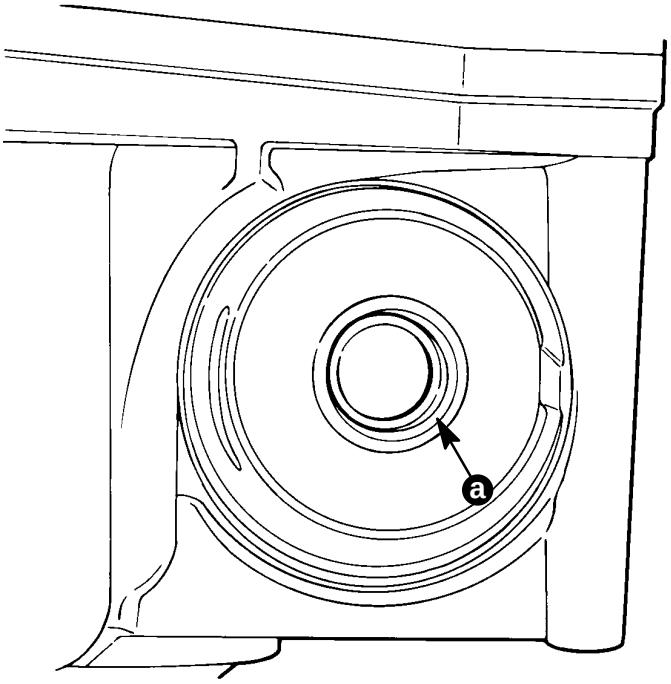
SEALS

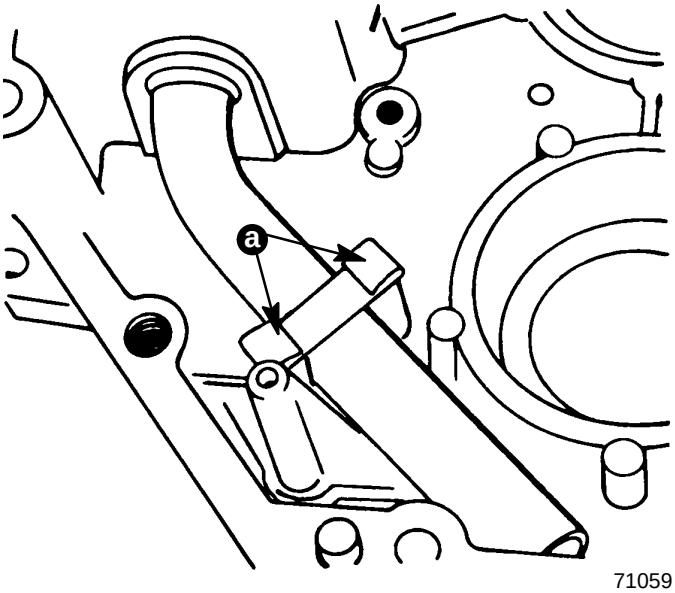
1. Remove suction pipe seal as follows:



27666

a - Seal

a. Bend tabs up away from screws.

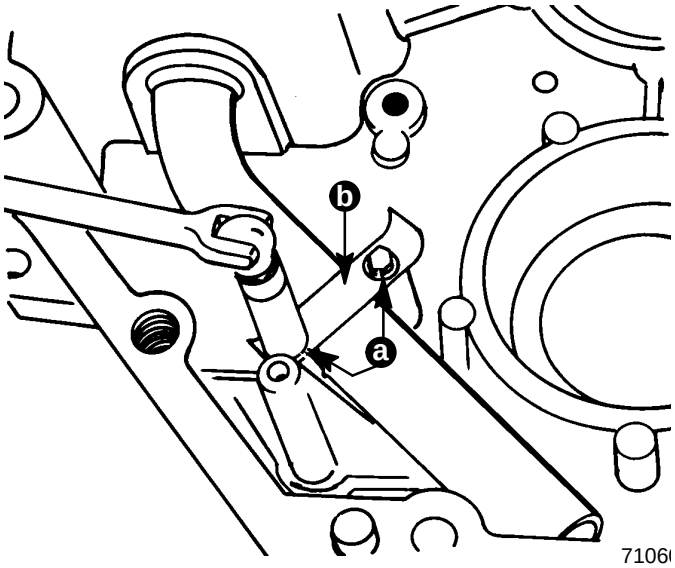


71059

a - Tabs

b. Remove screws and hold-down plate.

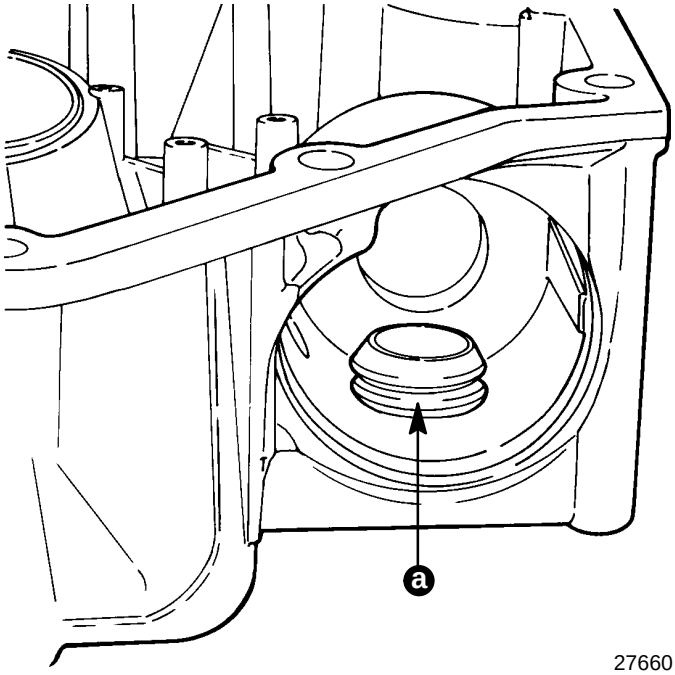
c. Remove suction pipe by pulling downward out of seal.



7106

a - Screws
b - Hold Down Plate

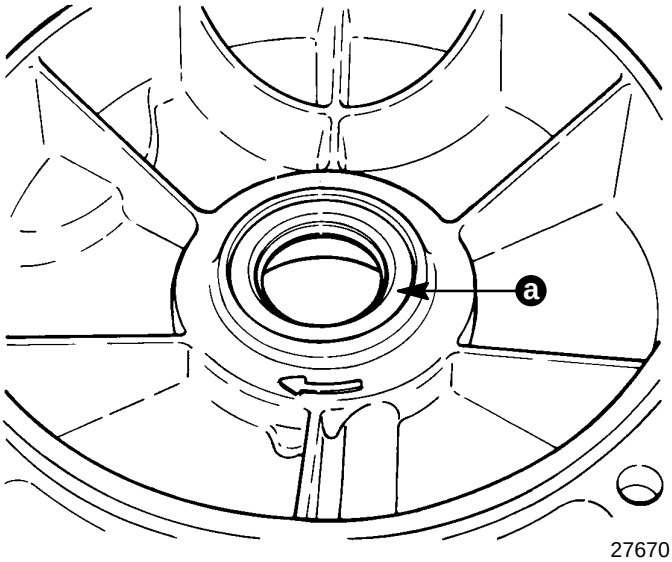
d. Remove seal from top side.



27660

a - Seal

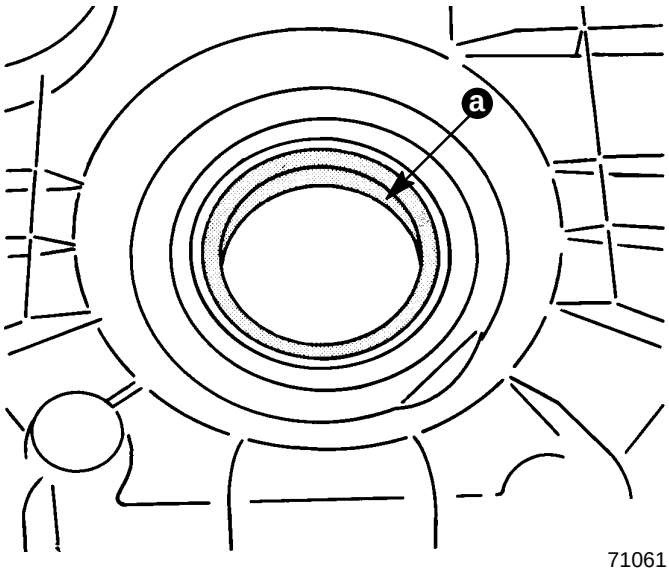
2. Remove input shaft seal using appropriate mandrel.



27670

a - Seal

3. Remove output shaft seals using appropriate mandrel.



71061

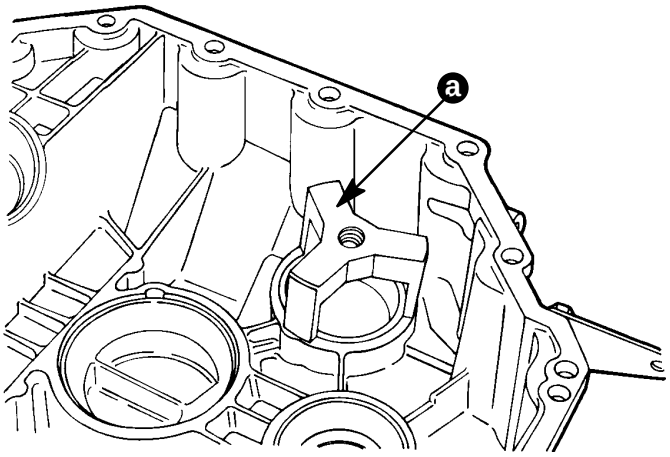
a - Seal

TAPERED ROLLER BEARING CUPS

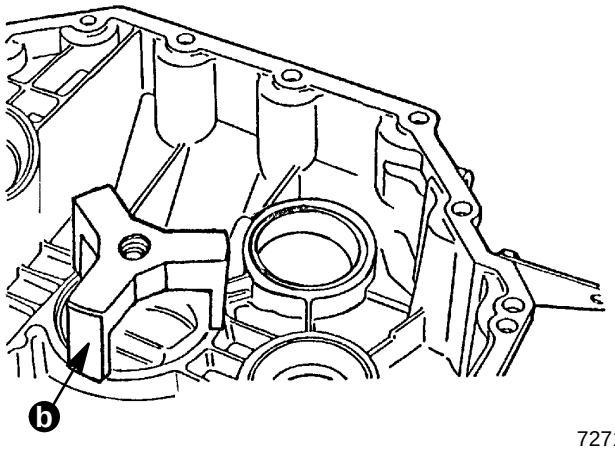
IMPORTANT: Do not remove tapered roller bearing cups unless replacing tapered roller bearings. Bearing and cup must be replaced as a set.

IMPORTANT: Do not mix up shims under cups on the input housing side. Shims are required for adjusting the bearing preload.

1. Pull tapered roller bearing cups from housing using special puller as follows:
   a. Position appropriate puller guide (large diameter or small diameter) over cup as shown.



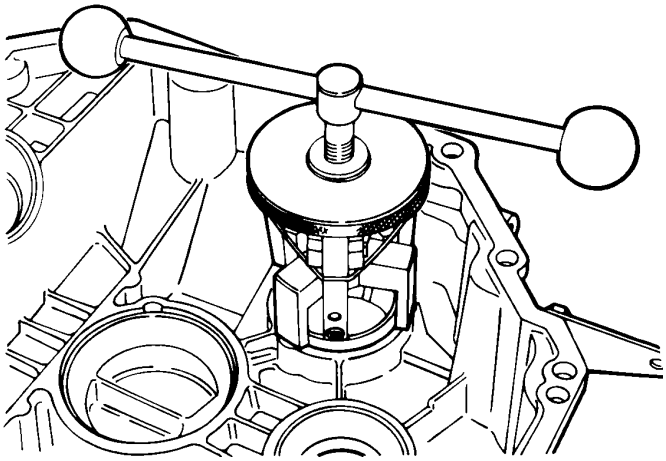
27681



72712

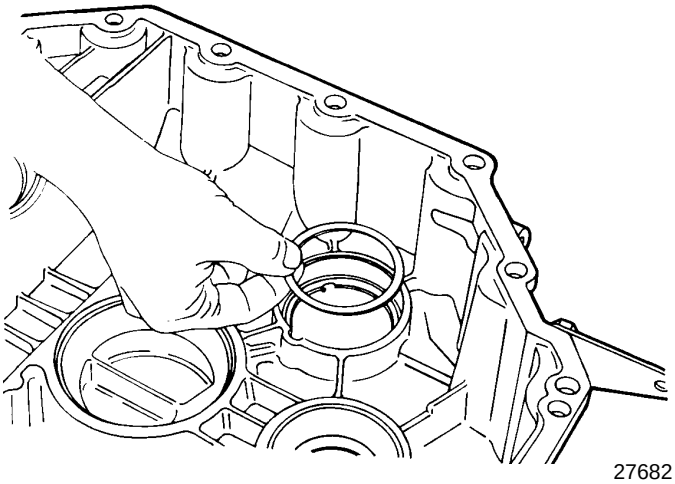
a - Small Diameter Puller Guide
b - Large Diameter Puller Guide

b. Pull bearing cup from housing using tool as shown.



27681

c. **Input Housing Side:** Remove and retain shims. DO NOT MIX UP.



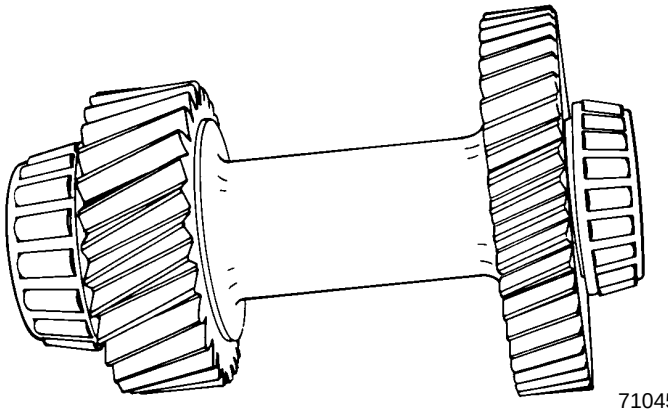
27682

TAPERED ROLLER BEARINGS

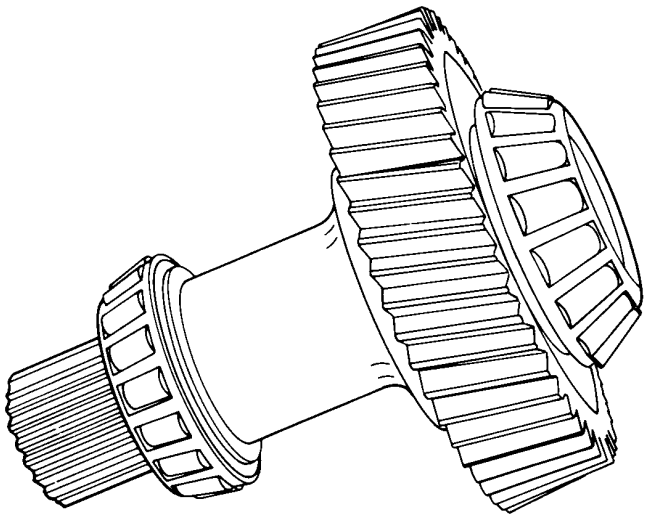
⚠CAUTION

Gears should never be removed from intermediate shaft or output shaft, as this will affect proper gear alignment.

1. Remove tapered roller bearings from intermediate shaft and output shaft by using a universal puller plate and pressing bearings off.



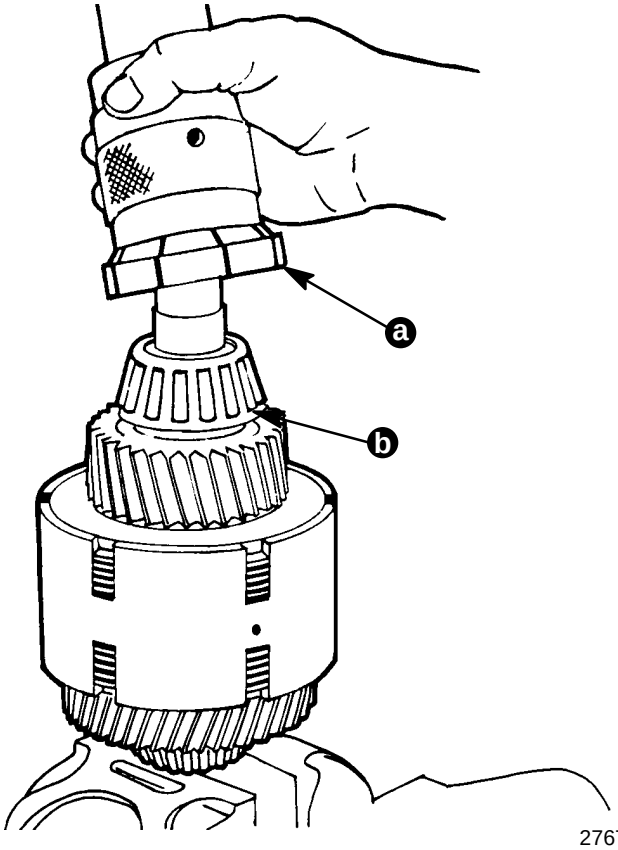
7104



71046

REVERSING CLUTCH, GEARS AND TAPERED ROLLER BEARINGS

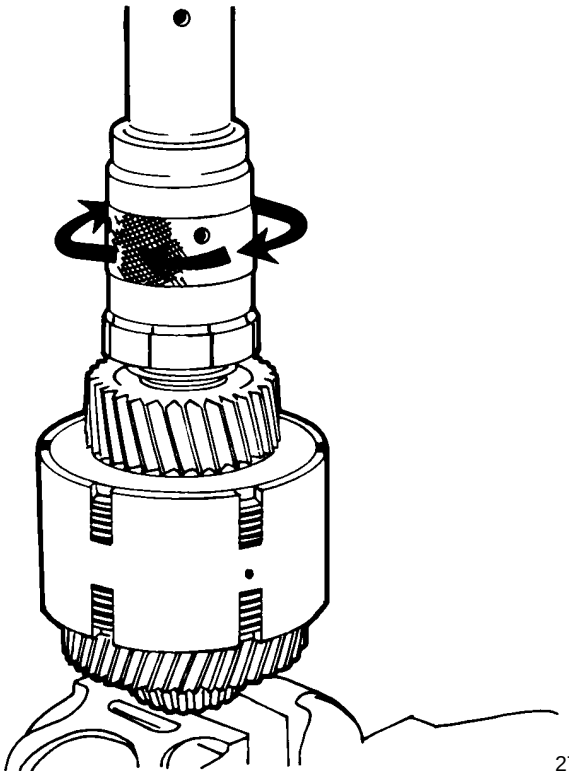
1. Remove tapered roller bearing from splined end of input shaft using special tool as follows:
   a. Place tool over tapered roller bearing. Ensure jaws of tool will be pulling on bottom edge of rollers and NOT on the cage.



27671

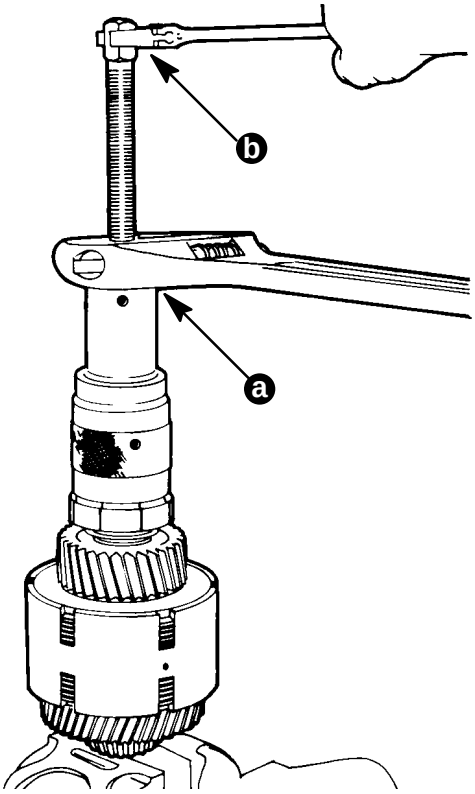
a - Jaws
b - Bottom Edge Of Rollers

   b. Tighten jaws onto bearing by turning on knurled part of tool. Tighten assembly.



27671

   c. Pull tapered roller bearing from shaft using tool as shown.



27672

a - Hold Tool Stationary
b - Turn Top Nut

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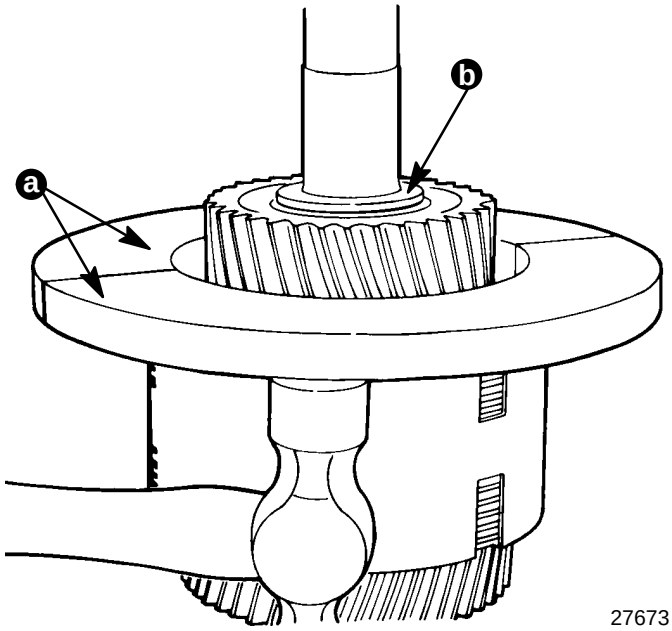
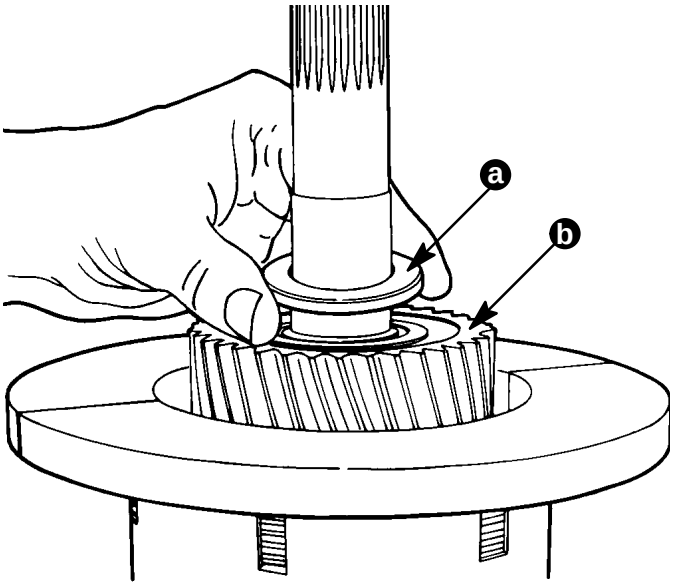
2. Remove butting ring from splined end of input shaft by installing special tool as shown and lightly tapping upward on tool.



27673

a - Special Tool
b - Butting Ring

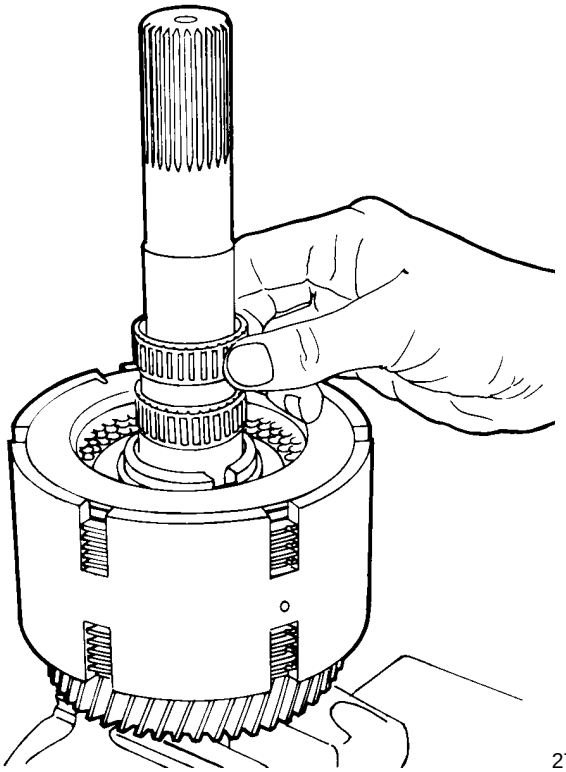
3. Remove butting ring and gear assembly.



27675

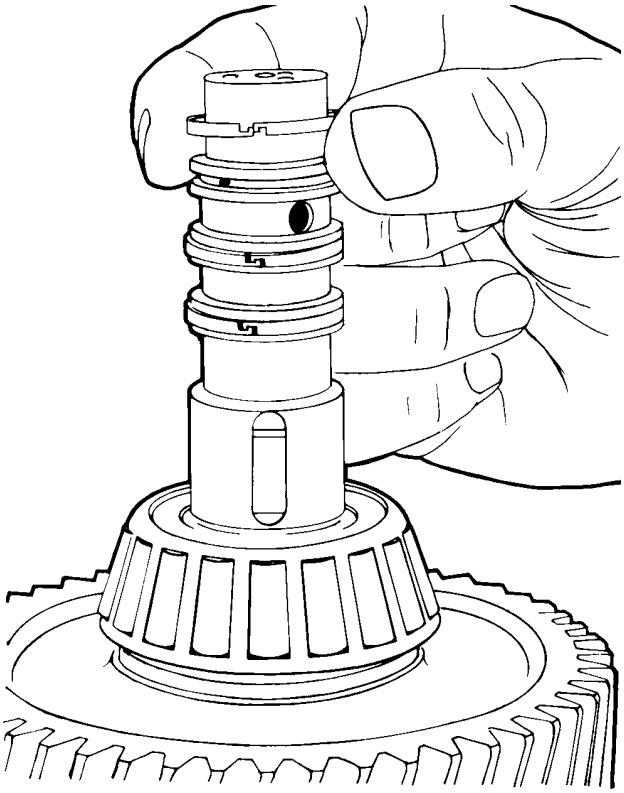
a - Butting Ring
b - Gear Assembly

4. Remove needle bearings.



27680

5. Remove piston rings from shaft.



27679

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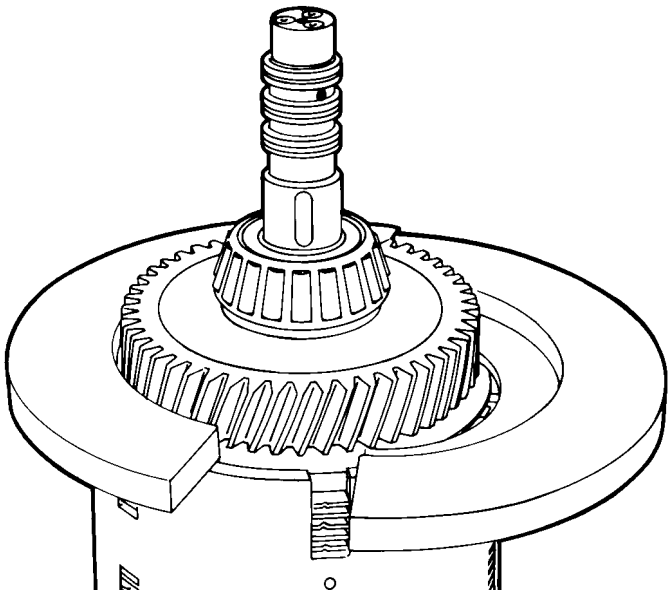
6. Remove tapered roller bearing, butting ring and gear from piston end of shaft using special tool as shown. Press all components off at the same time. Then remove needle bearings.

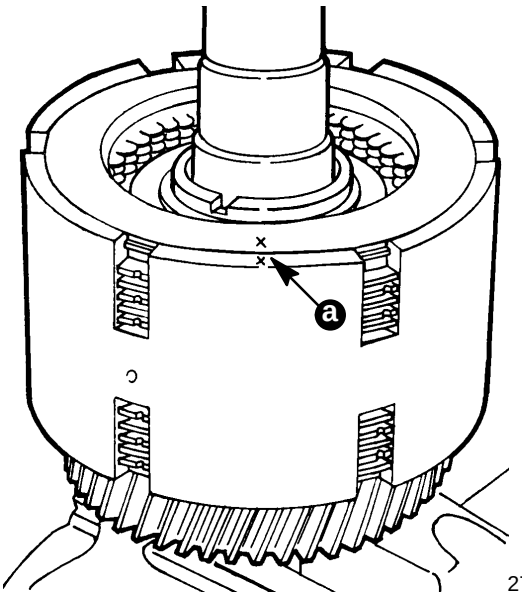


27673

CLUTCH DISCS

NOTE: *Discs on both sides of clutch are removed in the same manner.*

IMPORTANT: Reference marks are placed on the clutch housing and end disc to aid in locating the snap ring opening.

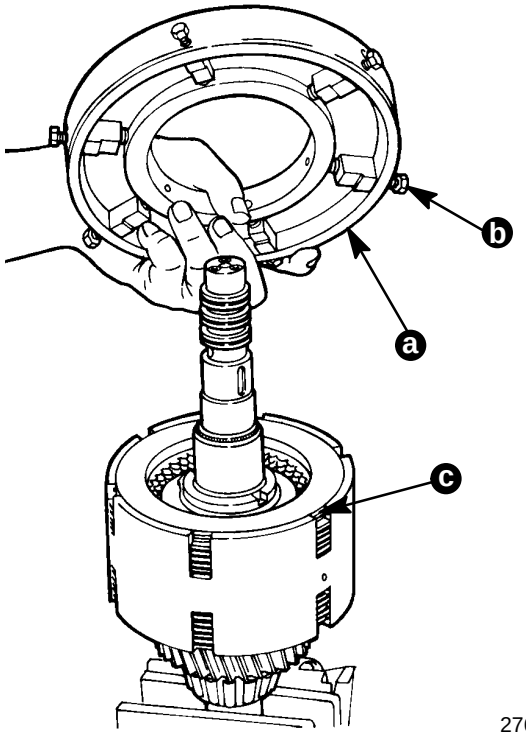


27675

a - Reference Marks

1. Position snap ring compression tool on clutch assembly so that compression screws are centered over slots in clutch housing.

2. Remove end disc and snap ring as follows:
   a. Tighten all compression screws until a slight resistance is felt.
   b. Tighten compression screws evenly (approximately 1/2 turn at a time).
   c. Tap up lightly on bottom edge of compression tool until snap ring pops up and out of groove in clutch housing.



27674

a - Snap Ring Compression Tool
b - Compression Screws (6)
c - Slots

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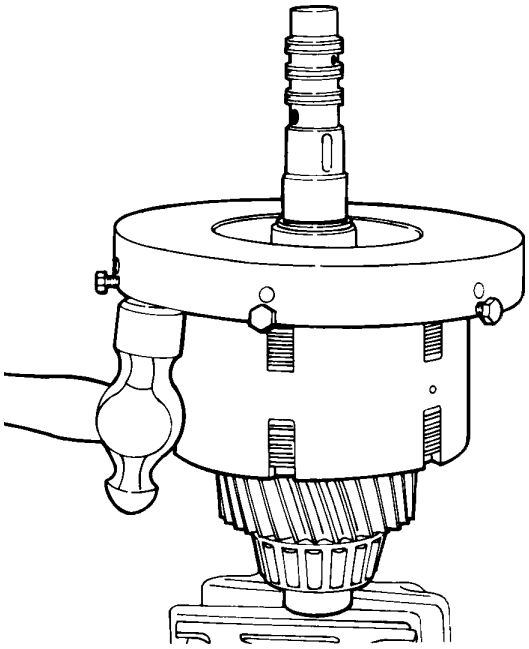
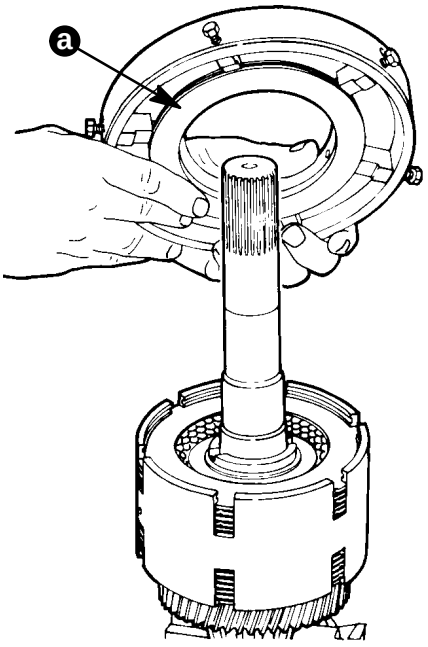


27675

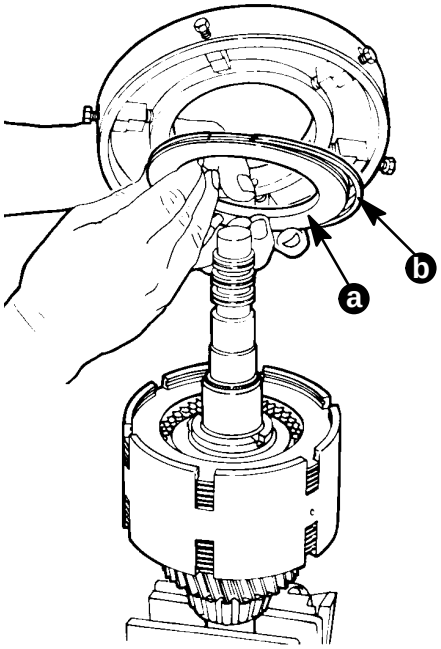
NOTE: *For ease of reassembly, end disc and snap ring should not be removed from tool unless their condition is questionable.*



27676

a - End Disc (Snap Ring Compressed)

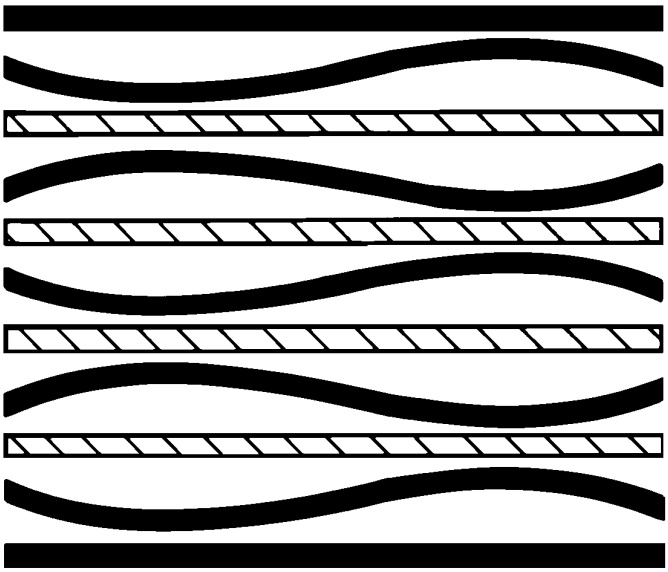
d. If necessary, remove end disc and snap ring from tool.



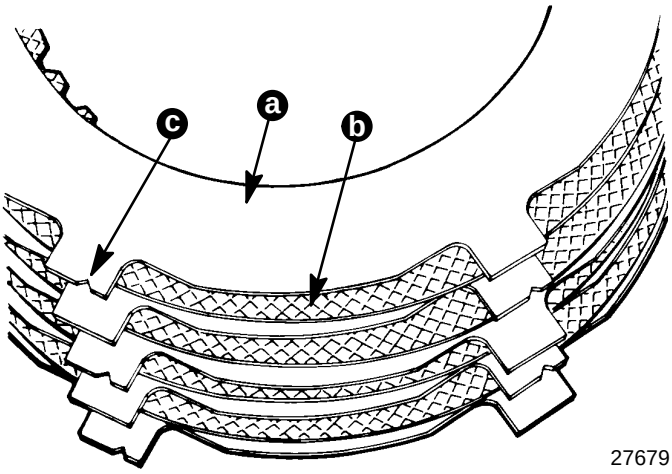
27676

a - End Disc
b - Snap Ring

IMPORTANT: Thrust discs have a wave pattern. These discs must be reinstalled in a specific pattern when reassembled. Make note of notches in thrust disc tabs, and how they are arranged.



50248



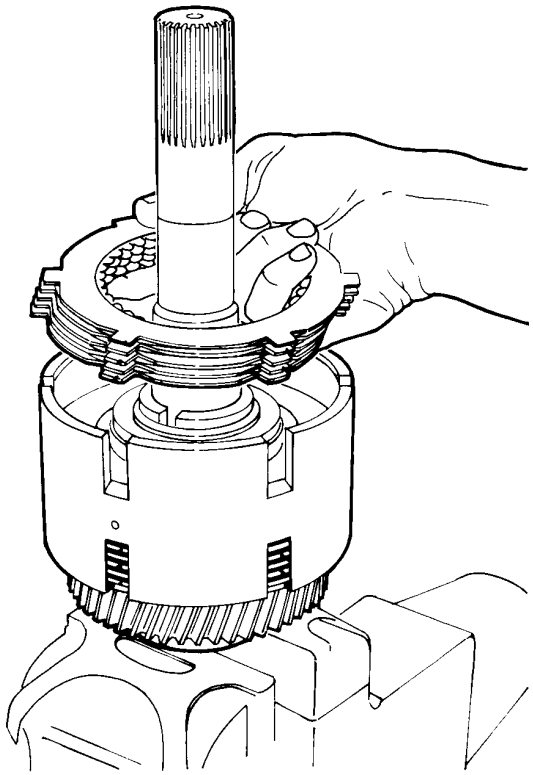
27679

630A Clutch Arrangement Shown (800AM Similar)

a - Thrust Discs (5 Per Side) See Note
b - Inner Discs (4 Per Side) See Note
c - Notches

NOTE: *800AM transmissions have additional thrust discs (6 total per side) and inner discs (5 total per side).*

3. Remove discs.



27680

4. Inspect thrust discs and inner discs for wear. Replace if there is any questionable wear.

5. Remove and inspect disc on opposite side of clutch in same manner.

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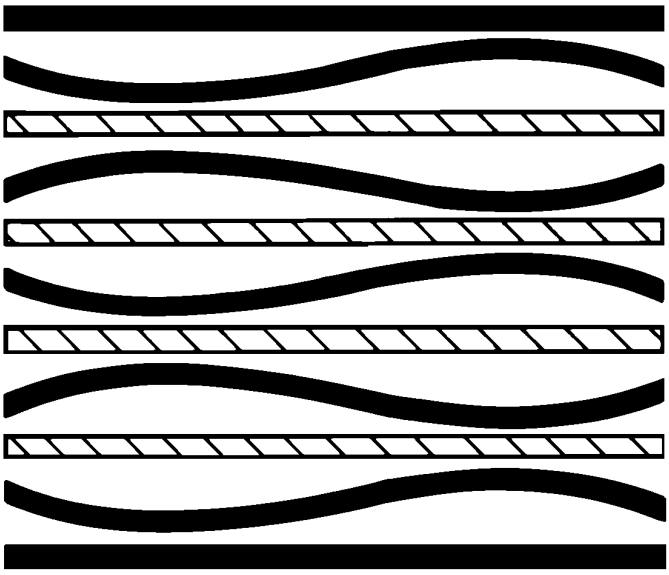
Reassembly

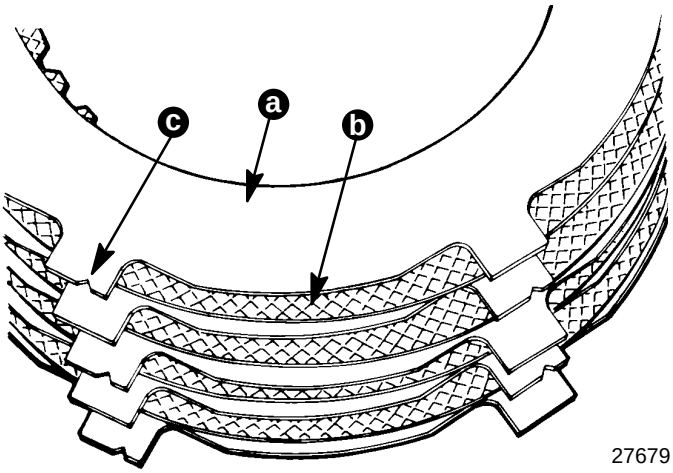
CLUTCH DISCS

IMPORTANT: Thrust discs have a wave pattern. These discs must be reinstalled in a specific manner as explained following.



50248

1. Arrange thrust discs and inner discs as shown. Ensure notches on thrust disc tabs are aligned as shown.



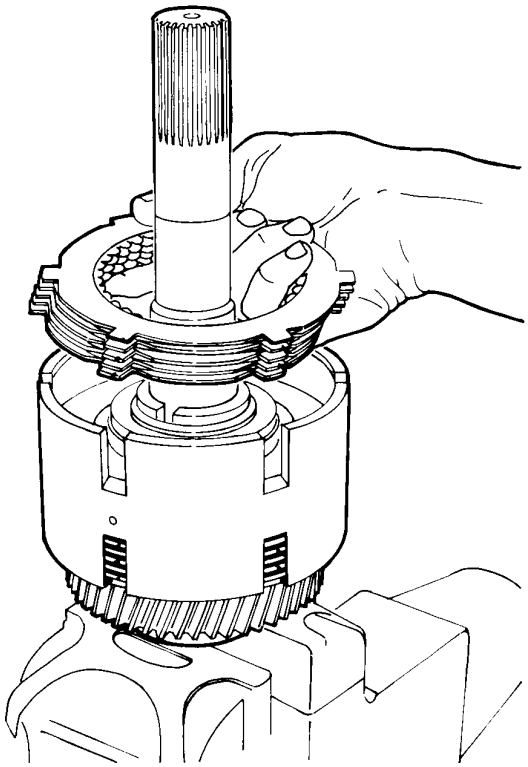
27679

630A Clutch Arrangement Shown (800AM Similar)

a - Thrust Discs (5 Per Side) See Note
b - Inner Discs (4 Per Side) See Note
c - Notches

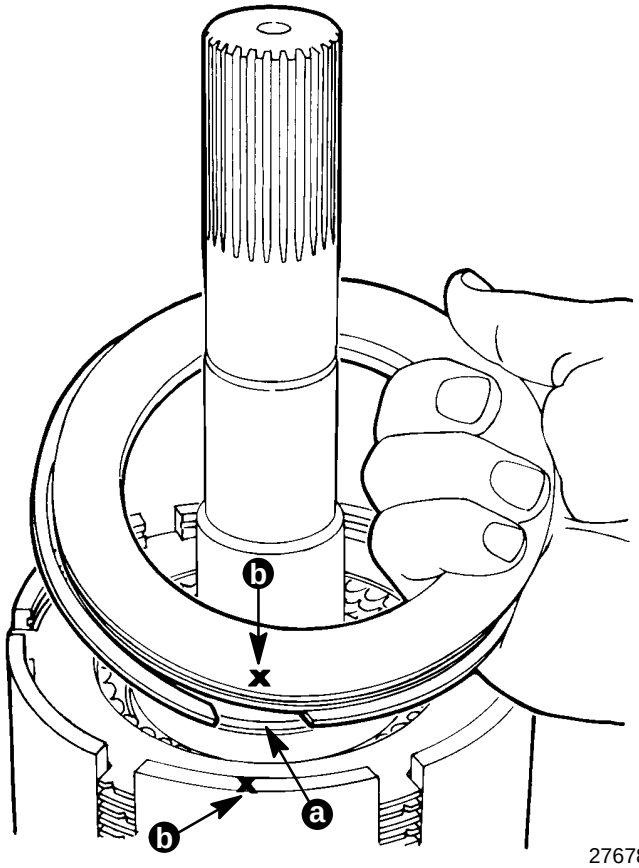
NOTE: *800AM transmissions have additional thrust discs (6 total per side) and inner discs (5 total per side).*

2. Install discs in clutch housing.



27680

3. Align snap ring opening with reference marks on end disc and clutch housing.



27678

a - Snap Ring Opening
b - Reference Marks

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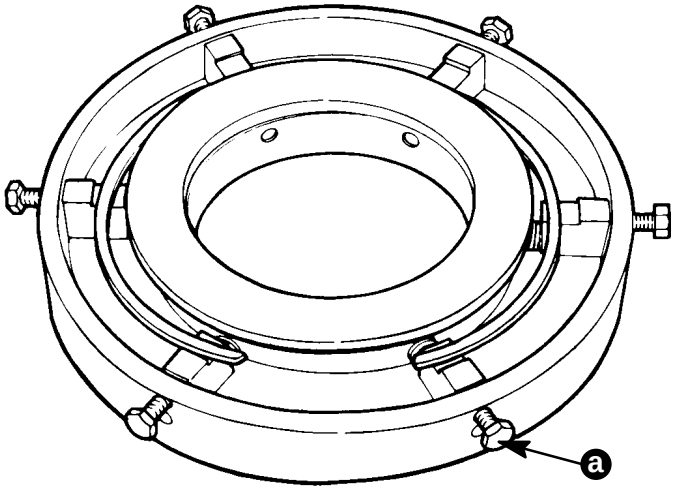
4. If end disc and snap ring were removed from tool, reinstall as follows:

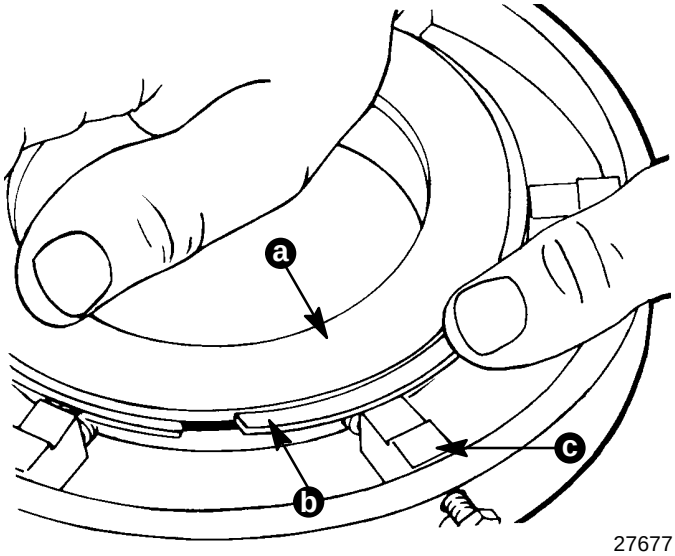
   a. Loosen all compression screws on tool.



27677

a - Compression Screws

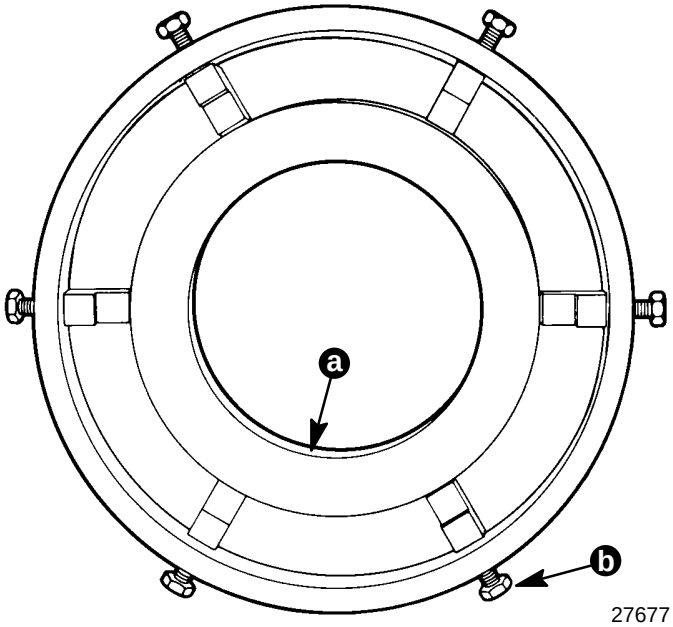
   b. Place snap ring into groove in end disc and compress by hand so that compression dogs will hold in on snap ring.



27677

a - End Disc
b - Snap Ring
c - Compression Dogs

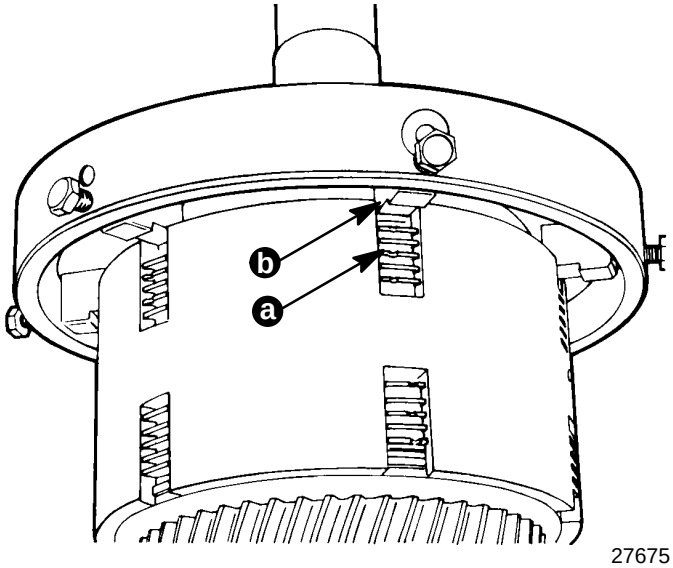
   c. Tighten compression screws evenly to completely compress snap ring into end disc.



27677

a - End Disc
b - Compression Screws

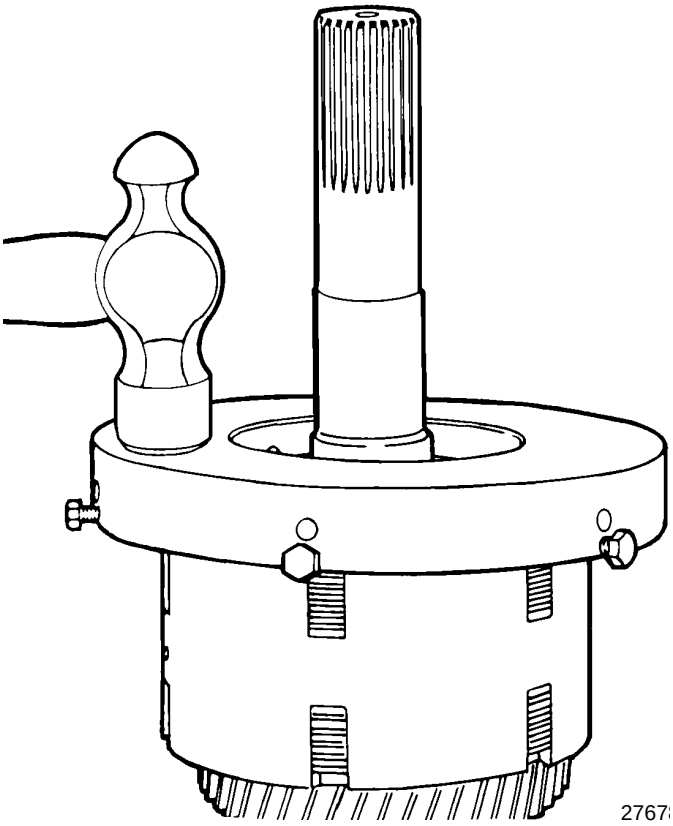
   d. Carefully lower end disc and special tool onto clutch housing and align compression dogs with slots in housing.



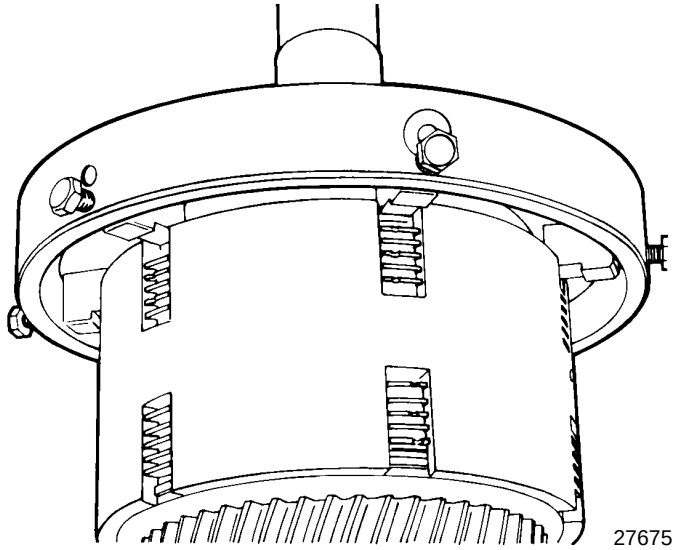
27675

a - Slots
b - Compression Dogs

5. Tap lightly around top of tool until end disc bottoms. Loosen compression screws and remove tool.

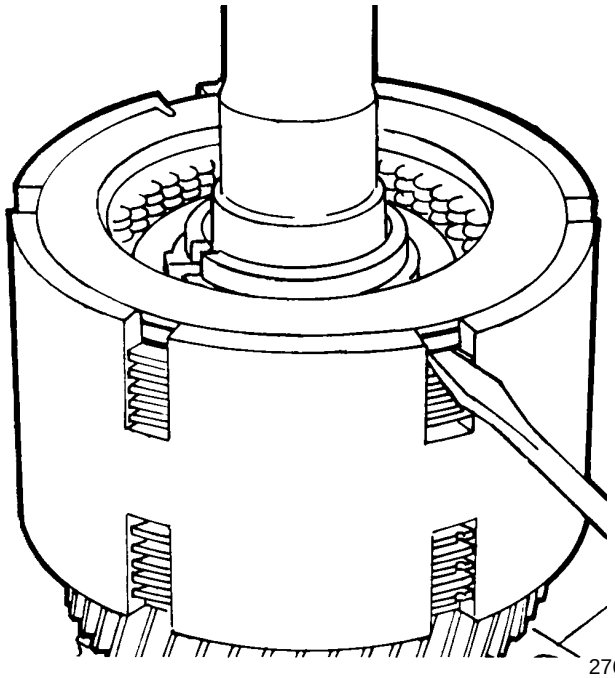


27678



27675

6. Double check that snap ring has been properly seated by prying up lightly on end disc.

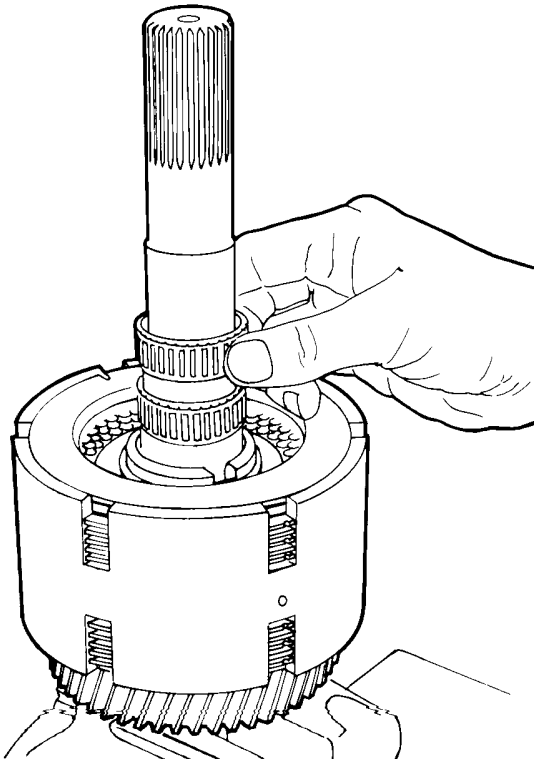


27679

7. Reinstall discs on opposite side of clutch in same manner.

NEEDLE BEARINGS

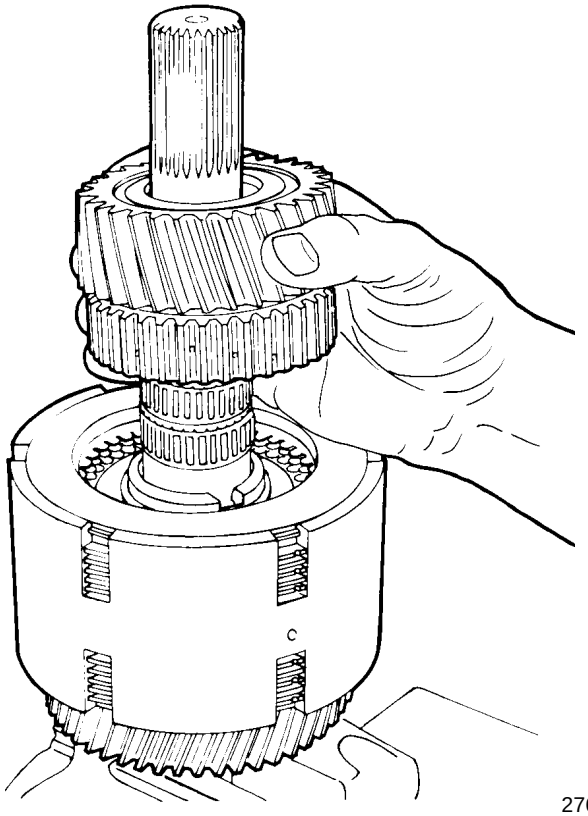
1. Reinstall needle bearings.



27680

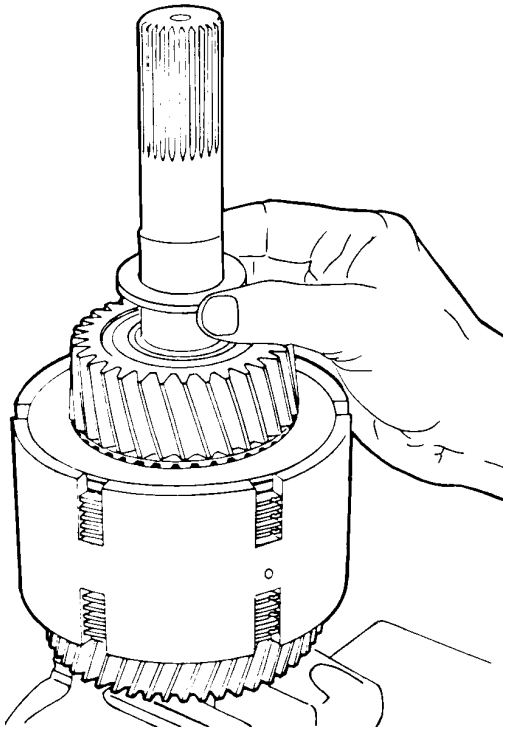
GEAR ASSEMBLY

1. Reinstall gear assembly. Twist gear assembly from side to side to allow splines to engage with inner discs. Ensure all inner discs are engaged with splines by observing through slots in clutch housing.



27673

2. Reinstall butting ring.



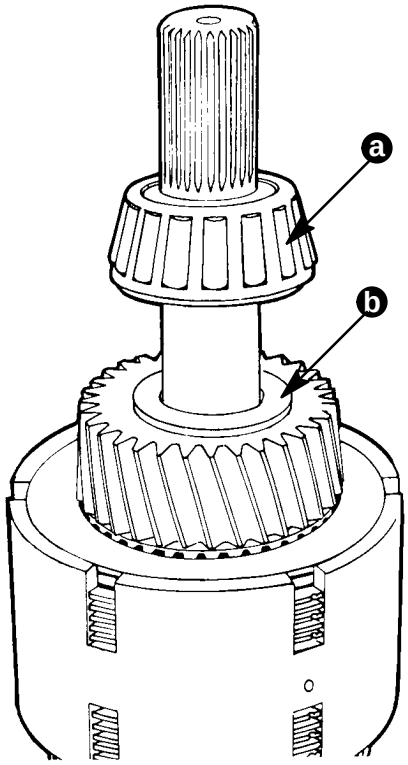
27672

TAPERED ROLLER BEARING

⚠CAUTION

Do not touch bearing once it has been heated. Severe burns could result. Use special protective gloves to handle bearing.

1. Heat inner race of tapered roller bearing using a torch lamp and press bearing onto shaft. When bearing has cooled (DO NOT cool with water), **carefully** tap bearing down to ensure proper seating against butting ring, using a soft (copper) punch. **Tap on inner race only.**



27674

a - Tapered Roller Bearing
b - Butting Ring

2. Install components on opposite side of clutch assembly in same manner.

⚠CAUTION

Use care in reinstalling piston rings on input shaft. Piston rings are brittle and may snap if spread too far open.

3. Reinstall piston rings on input shaft. Ensure ends of rings are coupled as shown. Then position rings so that ends are staggered so no two are aligned.

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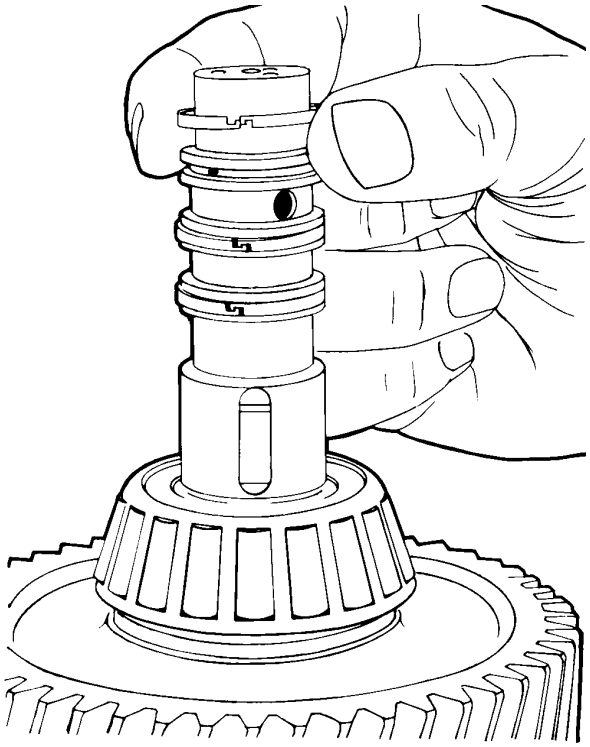


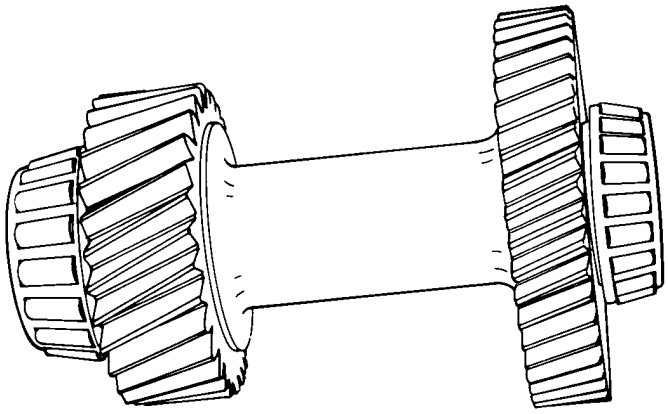
27679

INTERMEDIATE SHAFT

⚠WARNING

Do not touch bearing once it has been heated. Severe burns could result. Use special protective gloves to handle bearing.

1. Heat inner race of tapered roller bearing using a torch lamp and press bearing onto shaft. When bearing has cooled (DO NOT cool with water), **carefully** tap bearing to ensure proper seating against gear, using a soft (copper) punch. **Tap on inner race only.**



71045

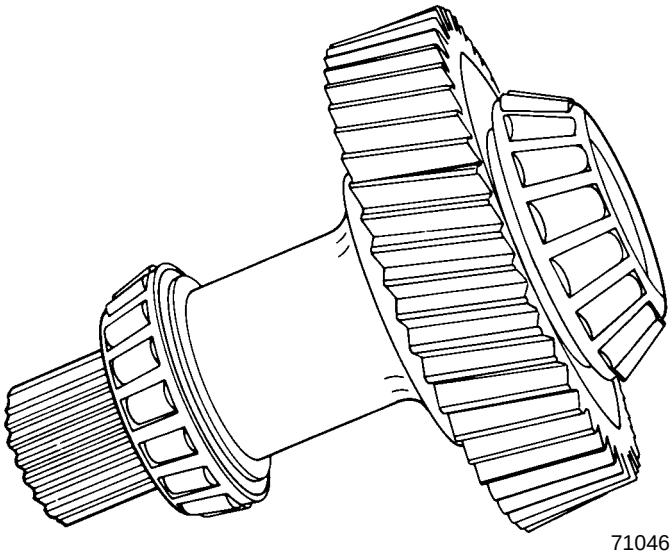
2. Install tapered roller bearing on opposite end of shaft in the same manner.

OUTPUT SHAFT

⚠WARNING

Do not touch bearing once it has been heated. Severe burns could result. Use special protective gloves to handle bearing.

1. Heat inner race of tapered roller bearing using a torch lamp and press bearing onto shaft. When bearing has cooled (DO NOT cool with water), drive bearing down against gear using a soft (copper) punch. **Tap on inner race only.**



71046

2. Install tapered roller bearing on opposite end of shaft in the same manner.

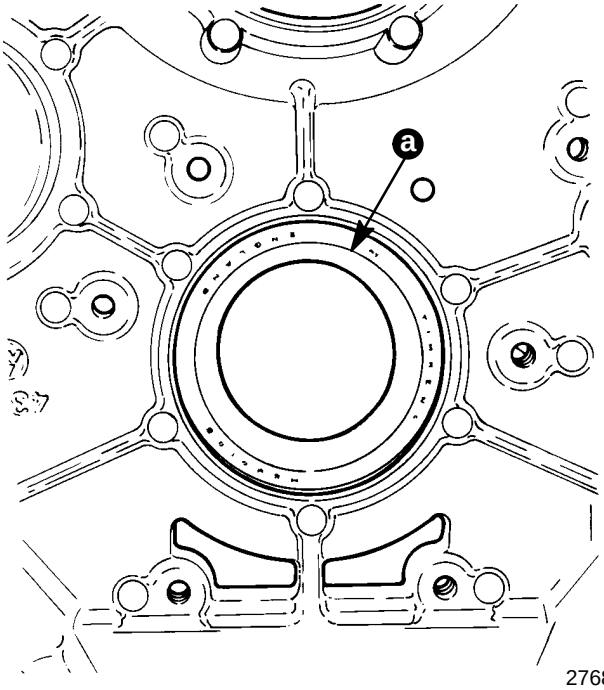
NOTE: *Tap bearing on splined end of shaft until it is seated against shoulder on shaft.*

PREASSEMBLY OF OUTPUT HALF OF HOUSING

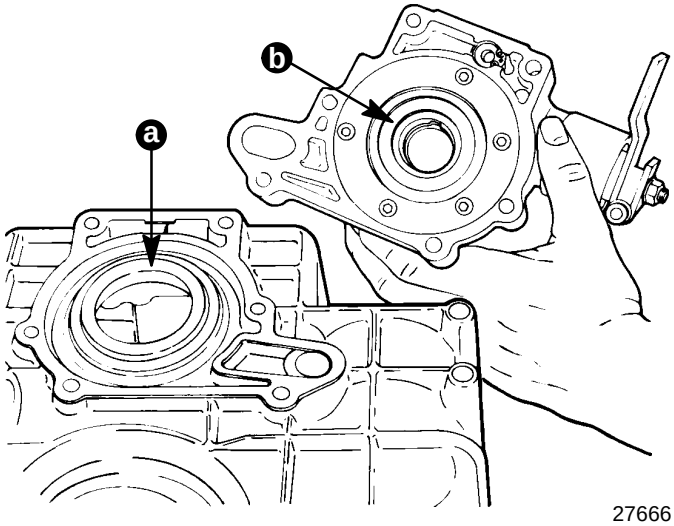
IMPORTANT: If tapered roller bearing cups were removed, ensure output shaft seal IS NOT in place, as it will be necessary to heat housing prior to installing bearing cups.

IMPORTANT: The tapered roller bearing cup on the input shaft (control block end) is properly positioned by bottoming out on the face of the control block assembly. It will be necessary to temporarily install control block to install this tapered roller bearing cup.

1. Temporarily install control block on outer housing. Tighten bolts securely.



27682



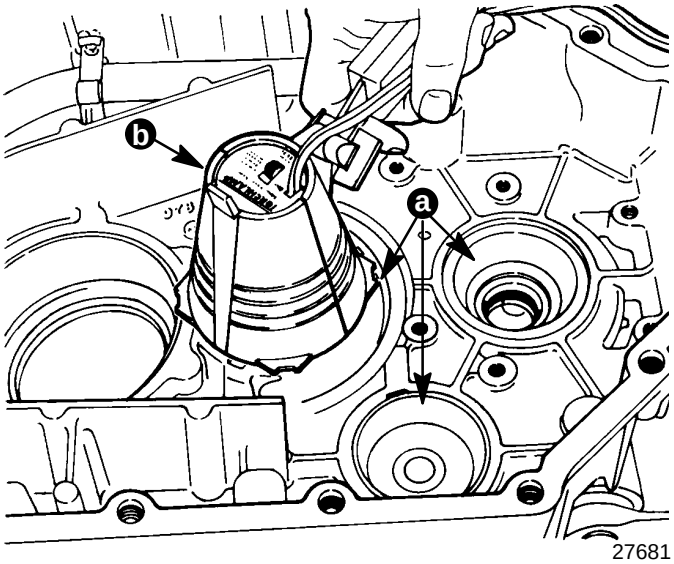
27666

a - Input Shaft Bearing Cup
b - Control Block Face

⚠WARNING

Use care in handling housing once it has been heated. Severe burns could result. Use special protective gloves to handle housing.

2. Heat bearing bores of housing using a torch lamp and install bearing cups using a suitable mandrel.



27681

a - Bearing Cups
b - Torch Lamp

3. Allow housing to cool (DO NOT cool with water) and then tap bearing cup with suitable mandrel to ensure it is properly seated.

4. Remove control block assembly.

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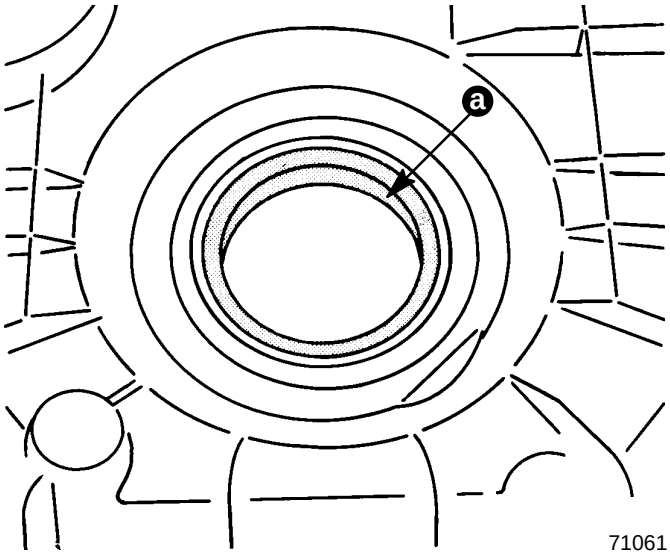
Output Shaft Seal

1. **If bearing were not replaced and no shimming is required,** push new seal onto special mandrel. Ensure seal will be positioned with lip of seal facing inward. Drive seal uniformly into bore of housing to the point that it is countersunk .040 in. (1 mm) with reference to housing surface.

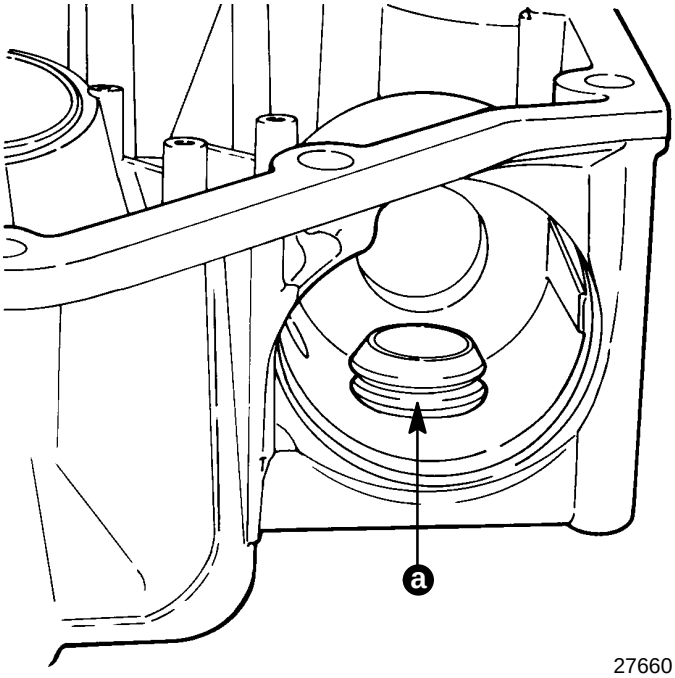


71061

Suction Pipe

a - Seal

1. Reinstall suction pipe seal in bottom of oil filter bore. Coat seal with ATF (automatic transmission fluid).

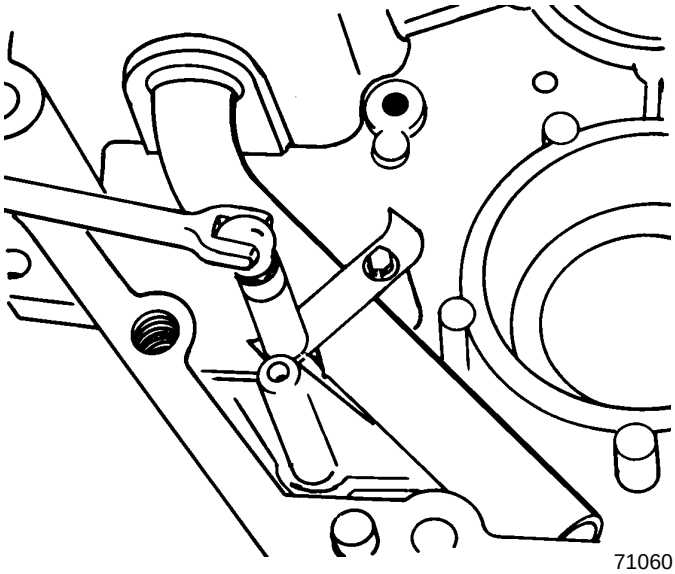


27660

a - Seal

2. Reinstall suction pipe. Place one drop of Quicksilver Loctite 8831 on screw threads. Then secure suction pipe down with retainer plate. Tighten screws securely.

3. Bend tabs down over screws.

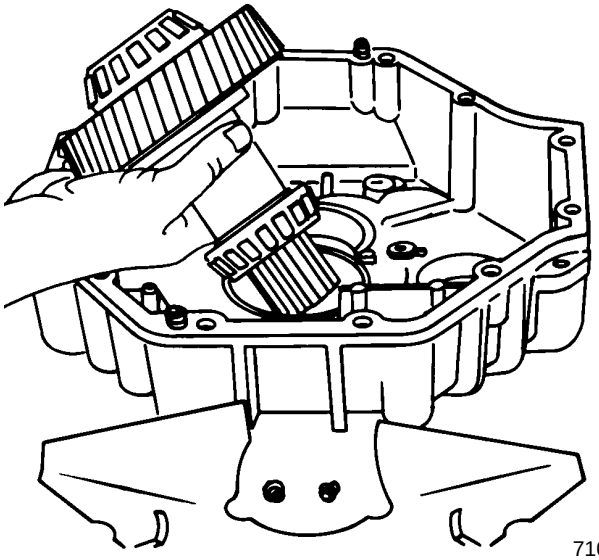


71060

Shafts and Baffle Plate

1. Coat tapered roller bearings with ATF.

2. Install output shaft.



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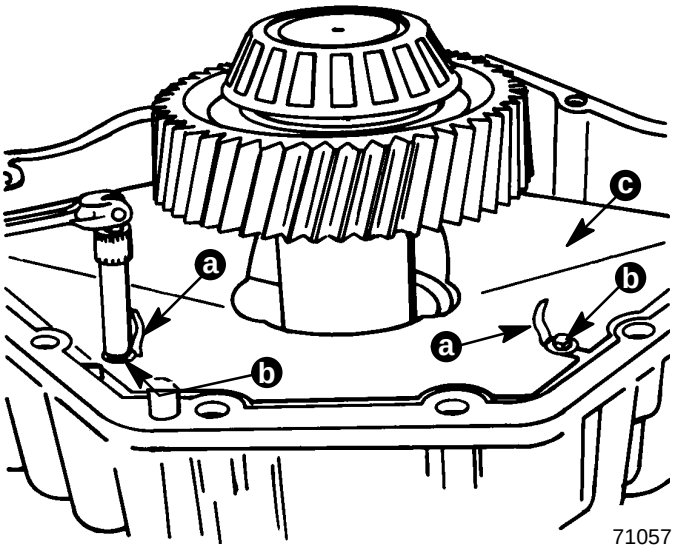
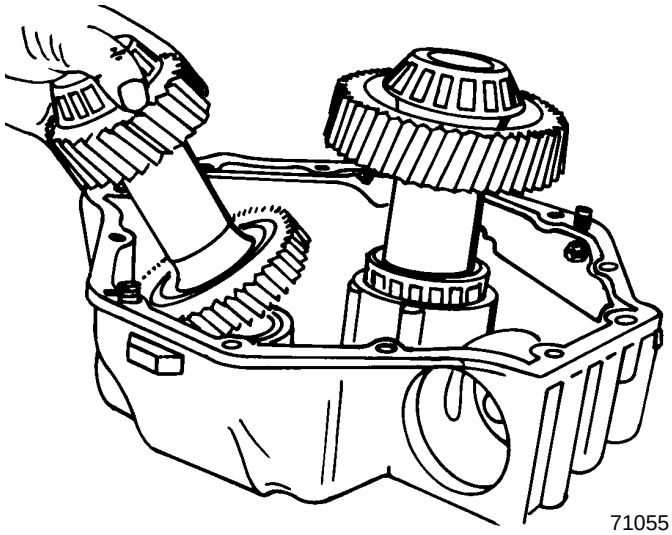
3. Install baffle plate. Apply one drop of Quicksilver Loctite 8831 to screws. Tighten screws securely and bend tabs down over screws.



71057

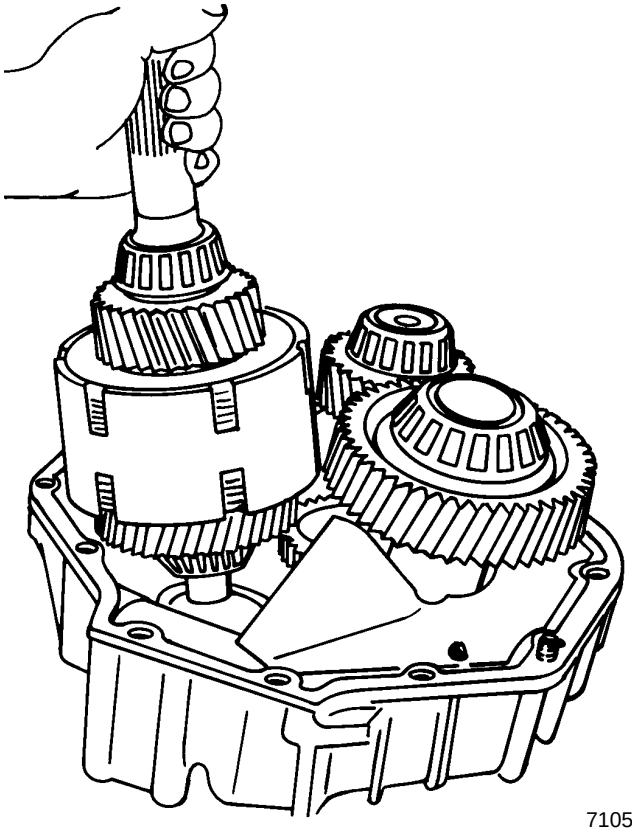
a - Tabs
b - Screws
c - Baffle Plate

4. Install intermediate shaft.

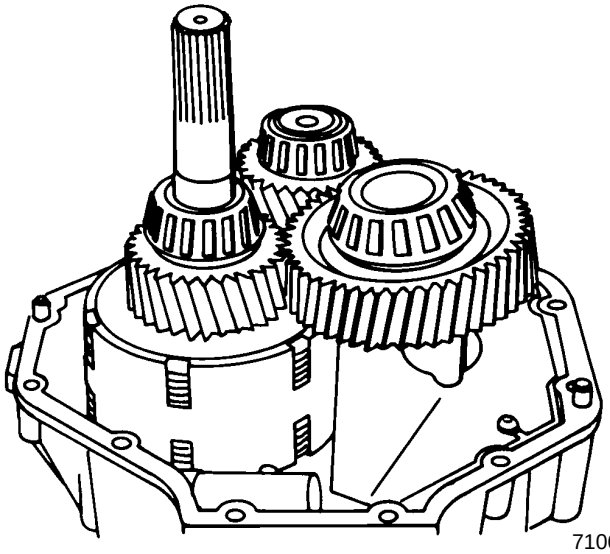


71055

5. Install input shaft. Ensure all gears mesh as shown.



71054



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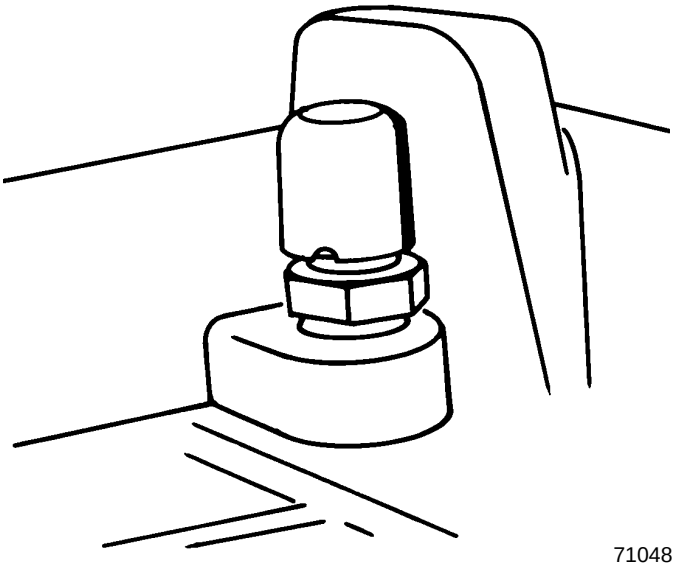
PREASSEMBLY OF INPUT HALF OF HOUSING

1. Install breather valve (do not overtighten).



71048

Bearing Preload Adjustment

IMPORTANT: If new tapered roller bearings have been installed, the preload must be readjusted. If bearings were not replaced, proceed to the final reassembly section.

NOTE: *The required preload of bearings of the individual shafts is obtained by using shims beneath the tapered roller bearing cups in the input half of the housing.*

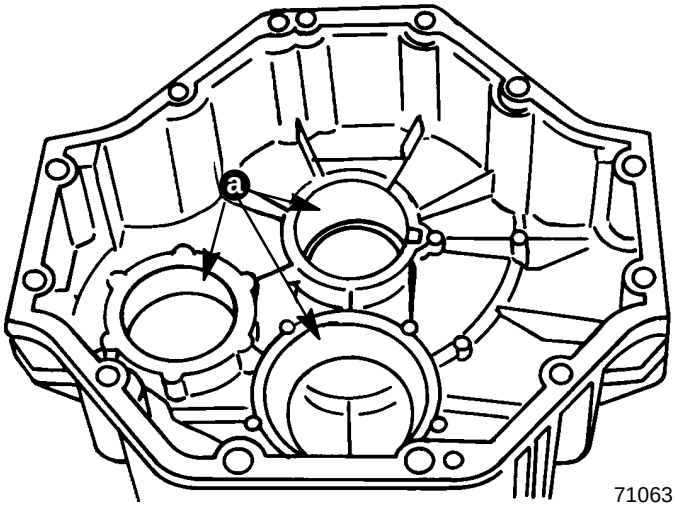
NOTE: *Shims which have been removed during disassembly may be reused.*

2. Subtract approximately .008 in. (0.2 mm) of shims from each bearing cup bore. Remove and set aside, but **do not** mix up.

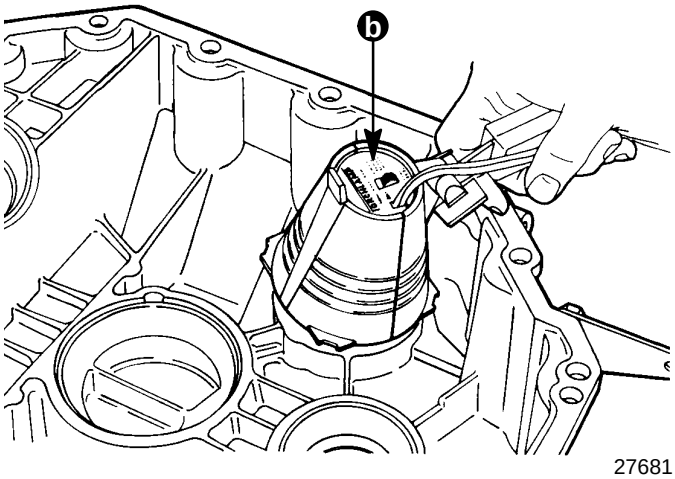
⚠ WARNING

Use care in handling housing once it has been heated. Severe burns could result. Use special protective gloves to handle housing.

3. Heat each tapered roller bearing cup bore with a torch lamp. Insert shims (less those removed) and bearing cups into appropriate bearing bores. When housing has cooled (DO NOT cool with water), tap bearing cups with a suitable mandrel to ensure that cups are fully seated.



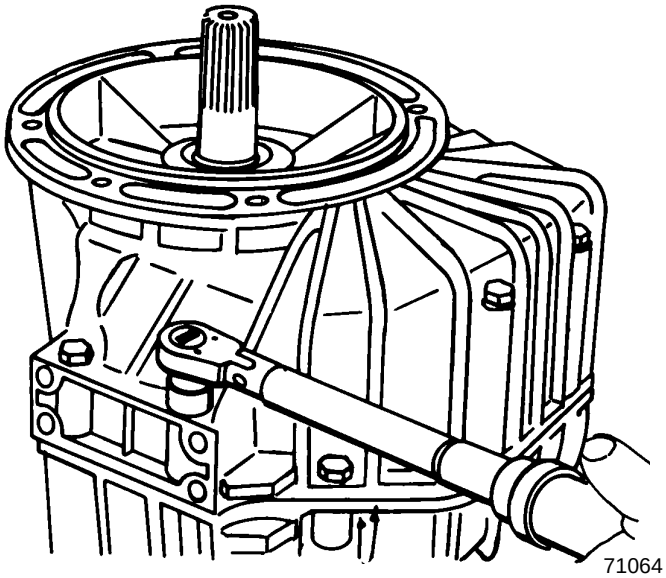
71063



27681

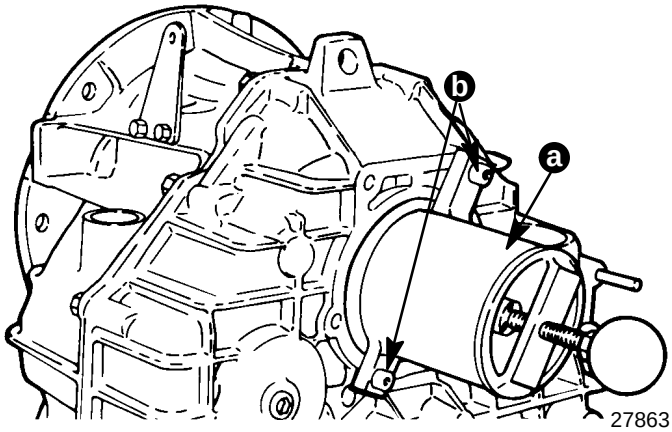
a - Bearing Cups
b - Torch Lamp

4. Install input half of housing onto output half. Ensure locator pins are in place. Install bolts and lockwashers and torque to 36 lb. ft. (49 N·m).


71064

Input Shaft Preload

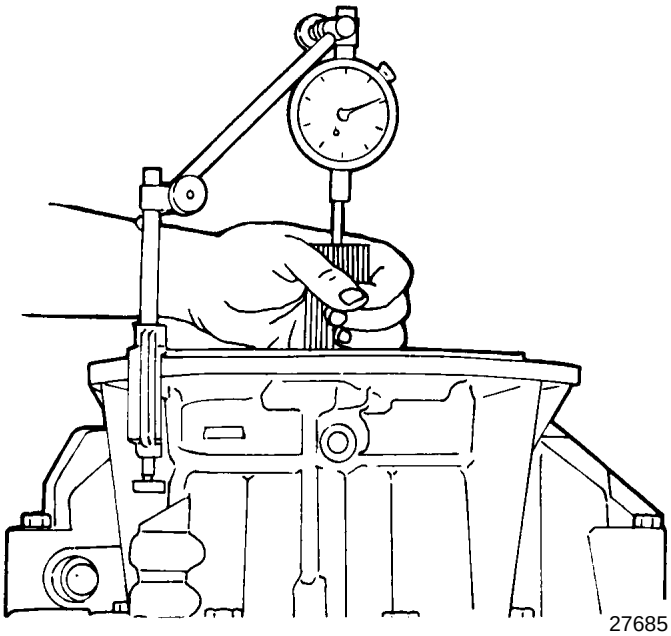
1. Measure bearing clearance as follows:
   a. Install special tool as shown. Tighten hold-down bolts securely.



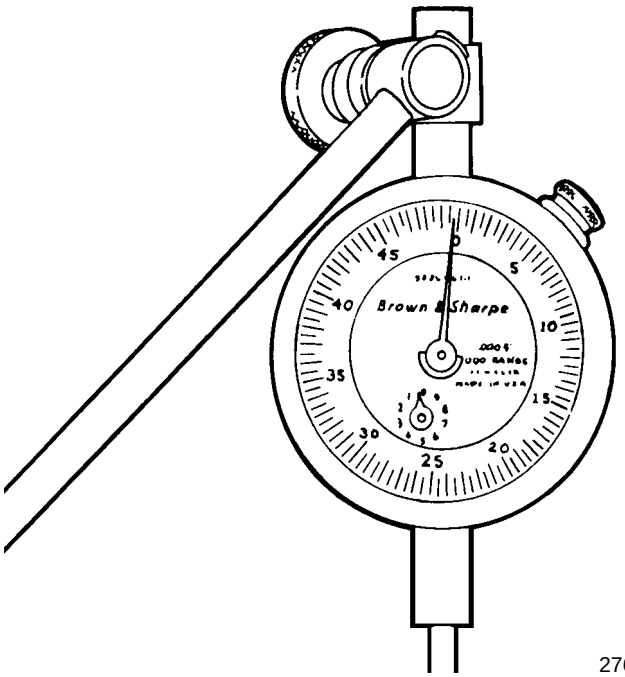
27863

a - Special Tool
b - Hold Down Bolts

   b. Mount dial indicator on input shaft. Turn input shaft several times to seat bearing.


27685

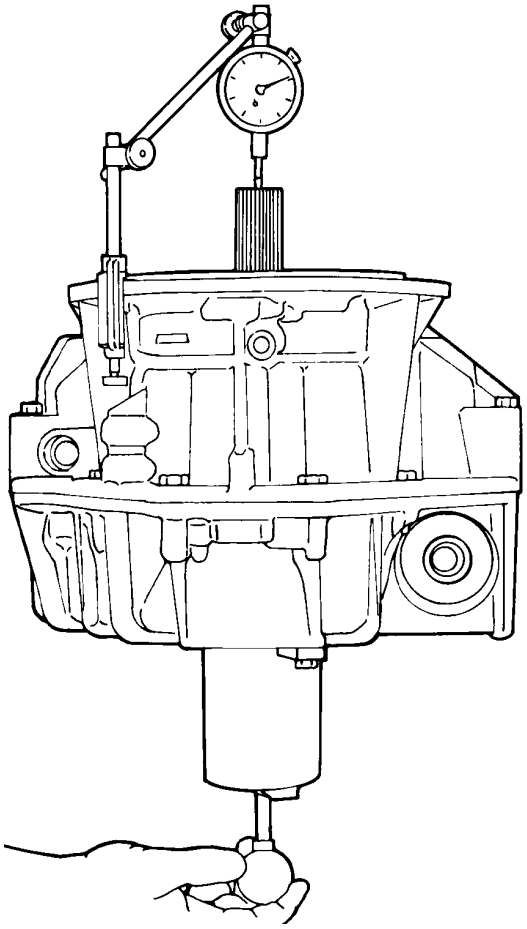
   c. Zero the dial indicator.



27685

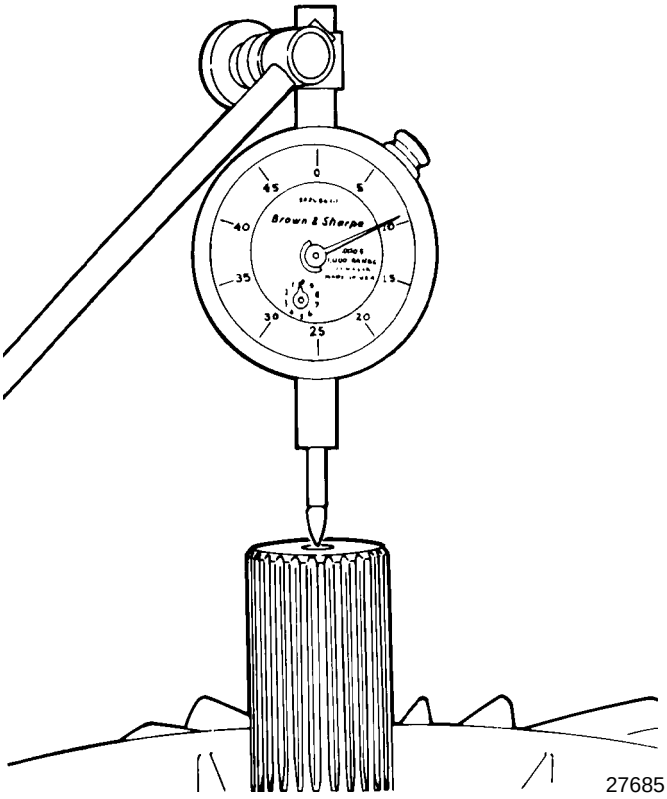
IMPORTANT: The following step should be done very carefully to obtain the actual bearing clearance. Avoid bumping the input shaft and turn very slowly on the special tool knob. (Shaft will only be moving a very small amount.)

d. Slowly turn the special tool knob clockwise to push the shaft upward. (Perform the above sequence several times to ensure an accurate reading.)



27682

e. Make note of reading. The bearing clearance measured **PLUS** the preload required is equal to the amount of shim thickness to be **ADDED.**



27685

Example:

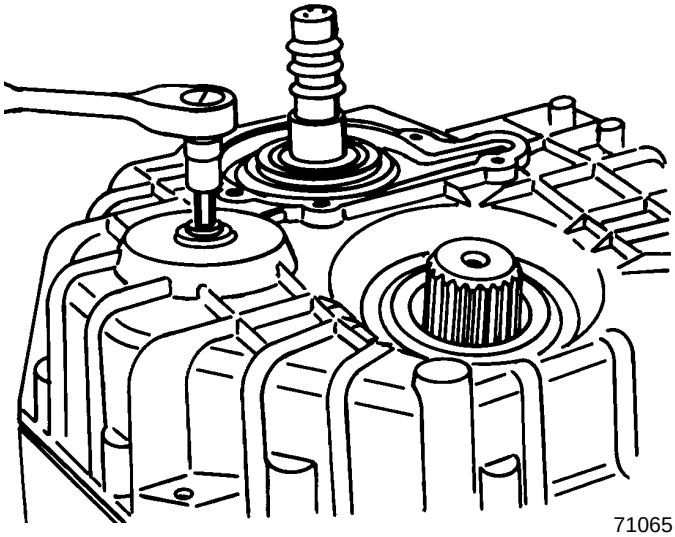
Bearing Clearance Measured.009 in.

\+ Bearing Preload Required.004 in.

\= Shims to Be Added .013 in.

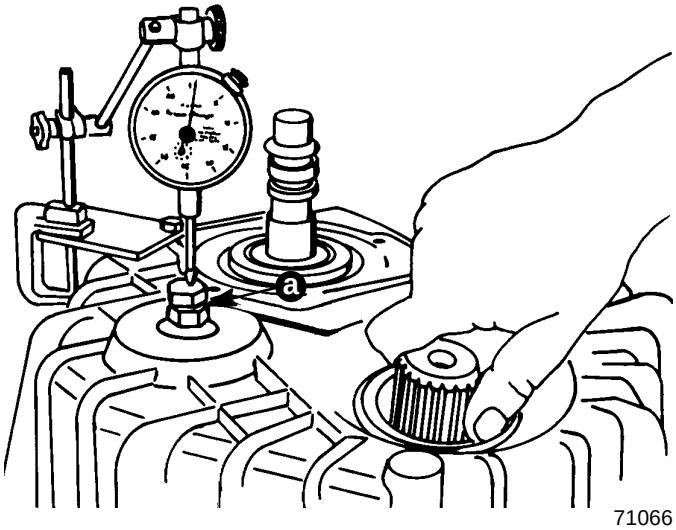
Intermediate Shaft Preload

1. Measure bearing clearance as follows:
   a. Remove hex plug from housing.



71065

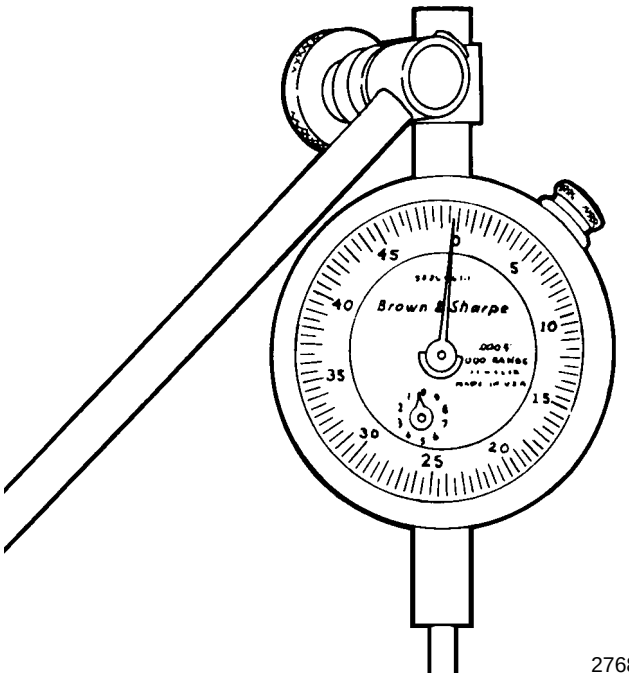
   b. Screw special bolt with nut into intermediate shaft and tighten snugly. Turn nut up until it touches bolt head.
   c. Mount dial indicator on bolt head. Turn output shaft several times to ensure bearing is seated.



71066

a - Special Bolt with Nut

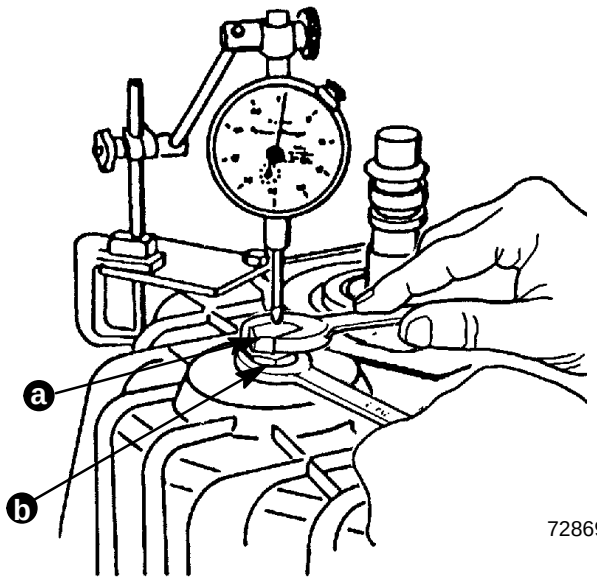
   d. Zero dial indicator.



27685

IMPORTANT: The following step should be done very carefully, to obtain the actual bearing clearance. Turn nut very slowly as shaft will only be moving a small amount.

   e. Hold bolt with one wrench and slowly turn down nut to pull shaft upward. (Perform the above sequence several times to ensure accurate reading.)



72869

a - Bolt - Hold Stationary
b - Nut - Turn To Move Shaft

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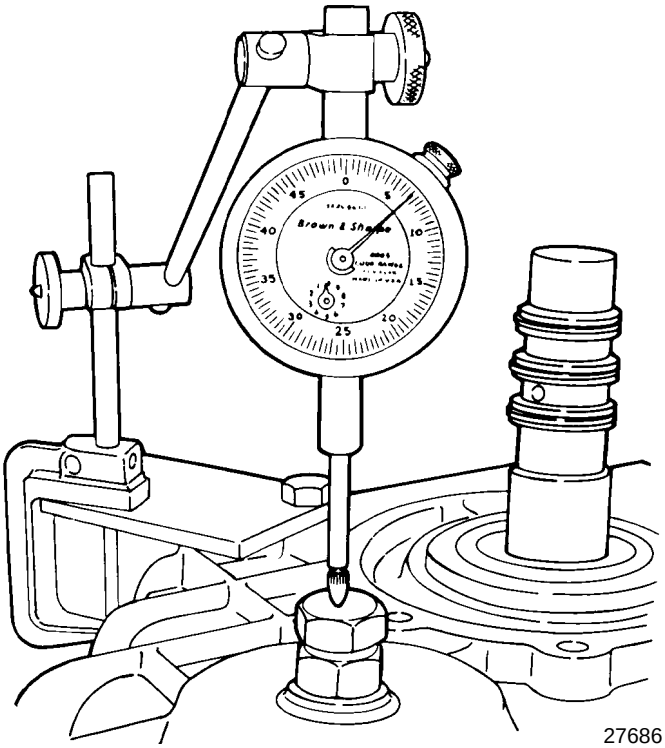
f. Make note of the reading. The bearing clearance measured **PLUS** the preload required is equal to the amount of shim thickness to be **ADDED.**



27686

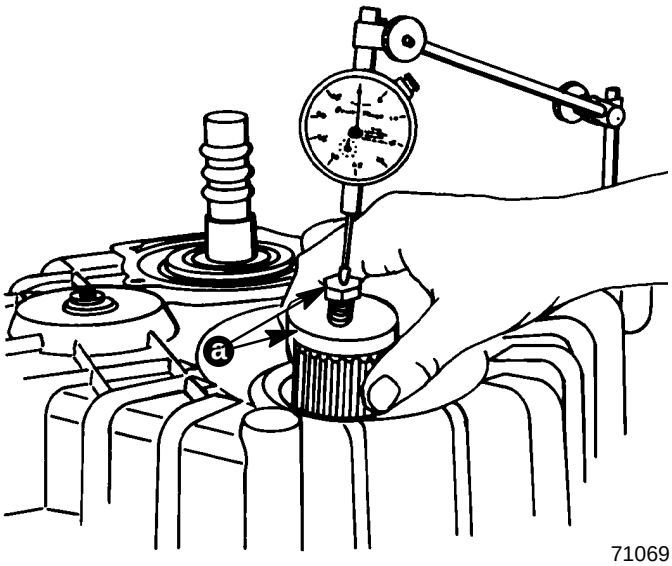
Example:

	Bearing Clearance Measured	.007 in.
+	Bearing Preload Required	.004 in.
=	Shims to Be Added	.011 in.

g. Remove dial indicator, special bolt and nut, and reinstall hex plug. Tighten securely.

Output Shaft Preload

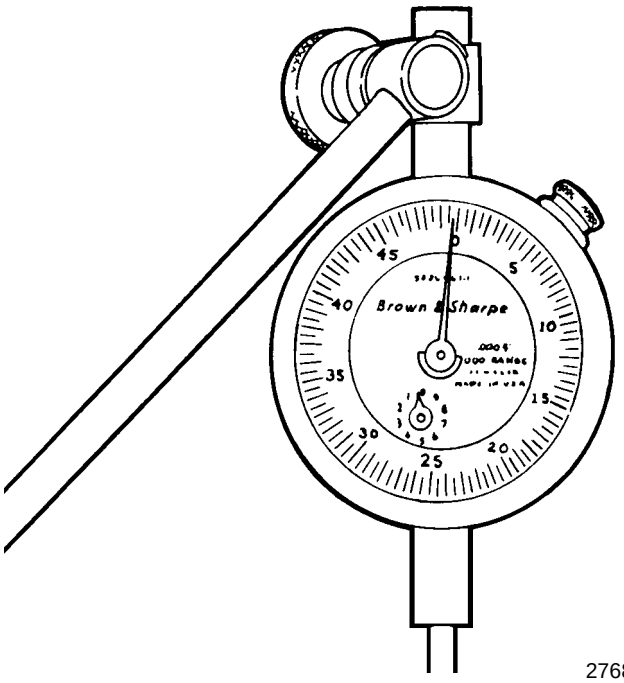
1. Measure the bearing clearance as follows:
   a. Install flange washer and bolt. Tighten snugly.
   b. Mount dial indicator on bolt head. Turn output shaft several times to ensure bearing is seated.



71069

a - Flange Washer and Bolt

   c. Zero dial indicator.



27685

IMPORTANT: The following step should be done very carefully to obtain the actual bearing clearance. Pry up gently and evenly to lift shaft. Shaft will only move a small amount.

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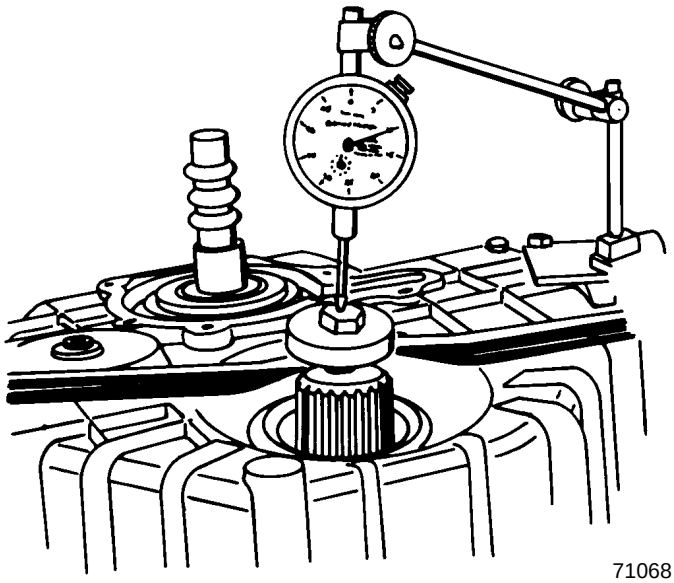
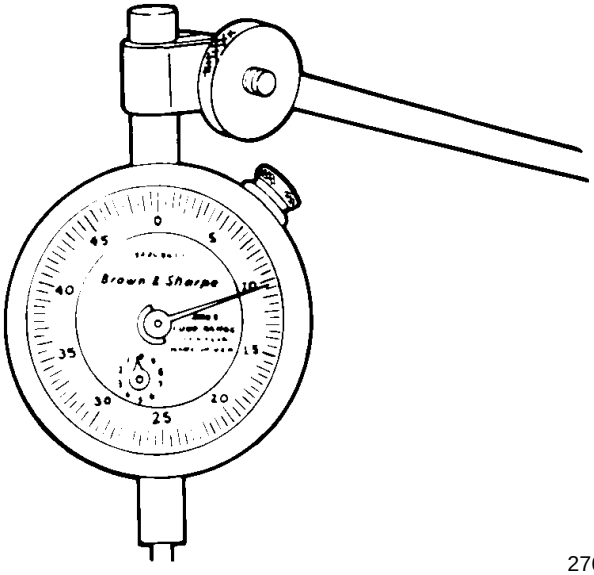
d. Pry up on washer to lift output shaft.



71068

e. Make note of the reading. The bearing clearance measured **PLUS** the preload required is equal to the amount of shim thickness to be **ADDED.**



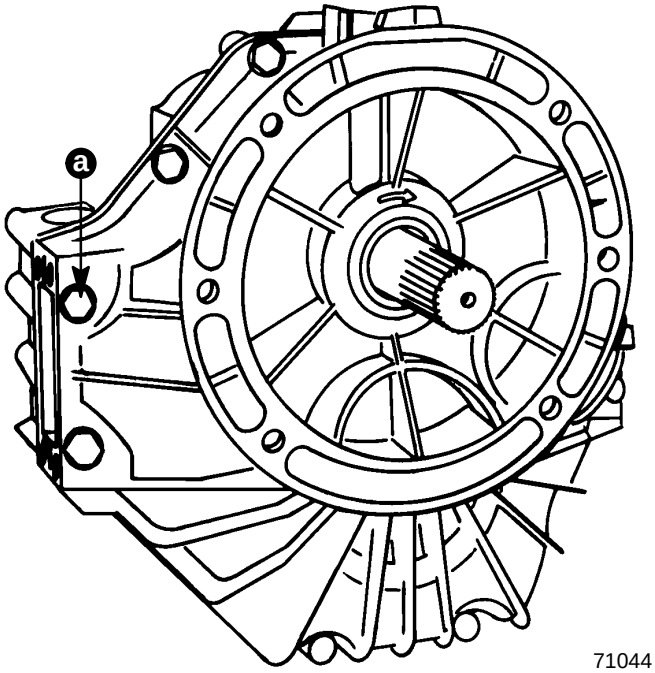
27686

Example:

	Bearing Clearance Measured	.010 in.
+	Bearing Preload Required	.004 in.
=	Shims to Be Added	.014 in.

f. Remove dial indicator. Remove bolt and flange washer.

2. When thickness of shims to be **ADDED** has been determined, the input half of housing must again be removed. Remove bolts and lockwashers, then lift off input half of housing.

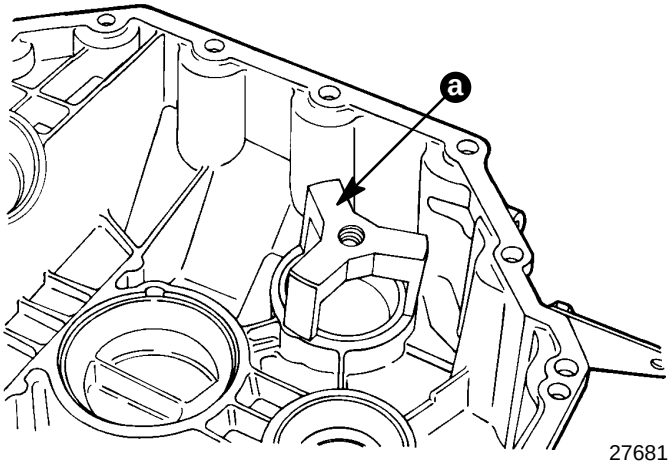


71044

a - Bolts

3. Remove tapered roller bearing cups from housing using special puller as follows:

   a. Position appropriate puller guide (large or small diameter) over cup as shown.



27681

a - Puller Plate

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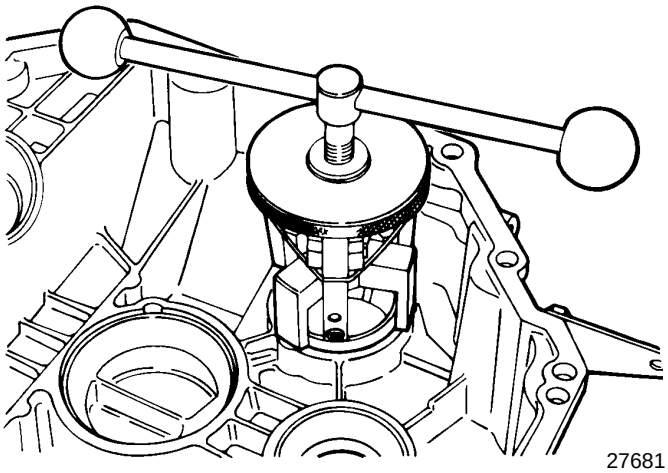
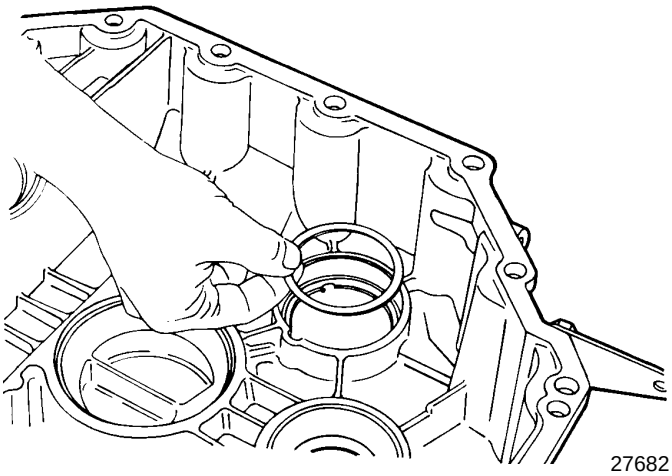
b. Pull bearing cup from housing as shown.



27681

4. Add the necessary amount of shims as determined previously to the appropriate bearing bores.

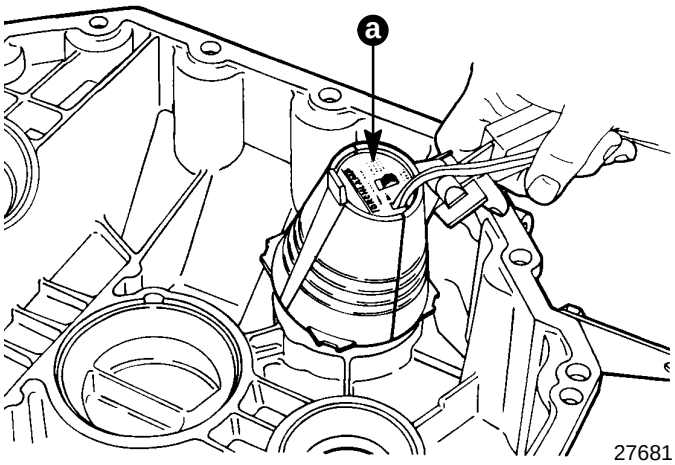


27682

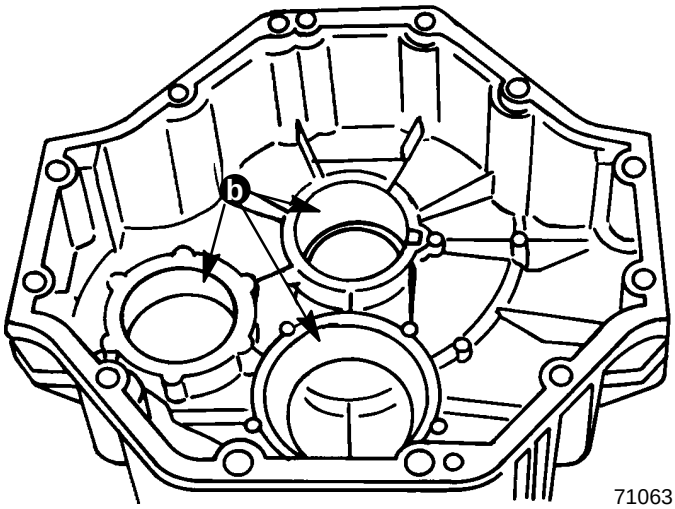
⚠WARNING

Use care in handling housing once it has been heated. Severe burns could result. Use special protective gloves to handle housing.

5. Heat each tapered roller bearing cup bore with a torch lamp. Install bearing cups into appropriate bore and tap into place using a suitable mandrel. When housing has cooled (DO NOT cool with water), tap bearing cups to ensure they are fully seated.



27681



71063

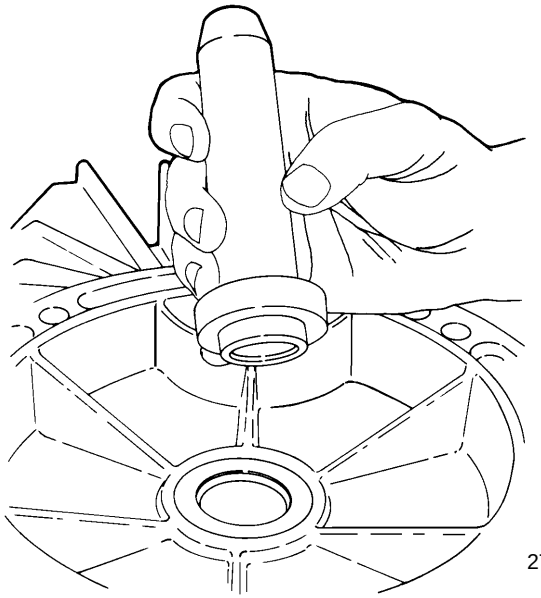
a - Torch Lamp
b - Bearing Cups

Final Assembly

INPUT SHAFT SEAL

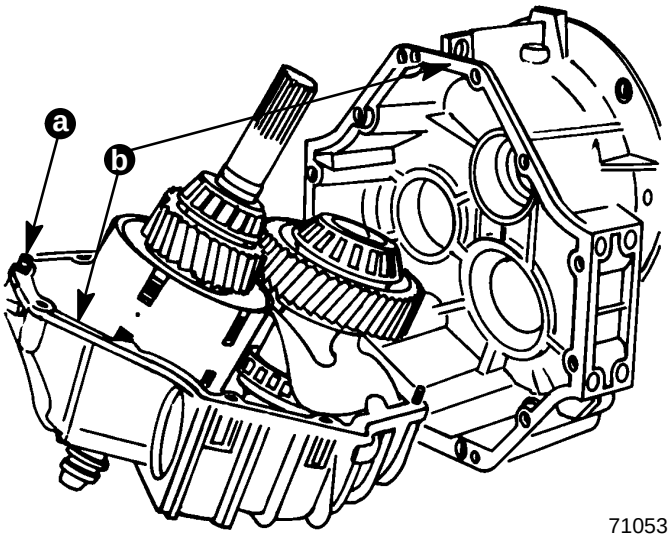
1. Push new seal onto special mandrel. Ensure seal will be positioned with lip of seal facing inward.

   Drive seal uniformly into bore of housing to the point that it is countersunk .040 in. (1 mm) with reference to housing surface.



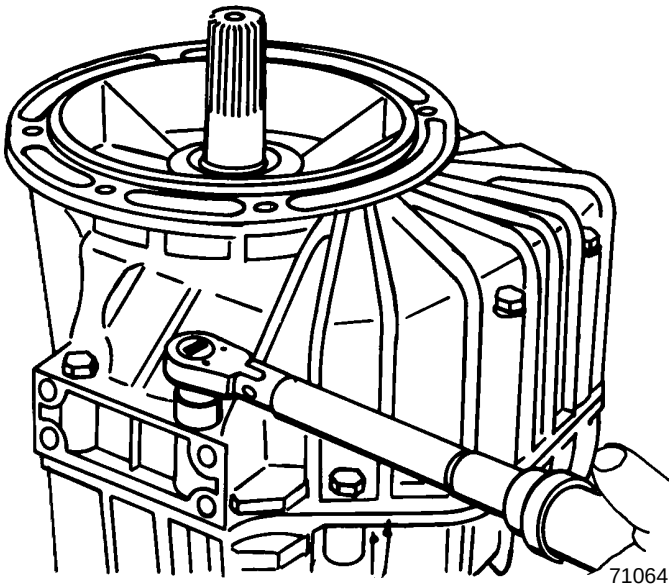
2. Coat lips of seals on input and output shafts with ATF.

3. Apply a thin layer of Loctite 515 Sealer to machined surfaces on housing halves. Reinstall input half of housing. Ensure locator pins are properly positioned.



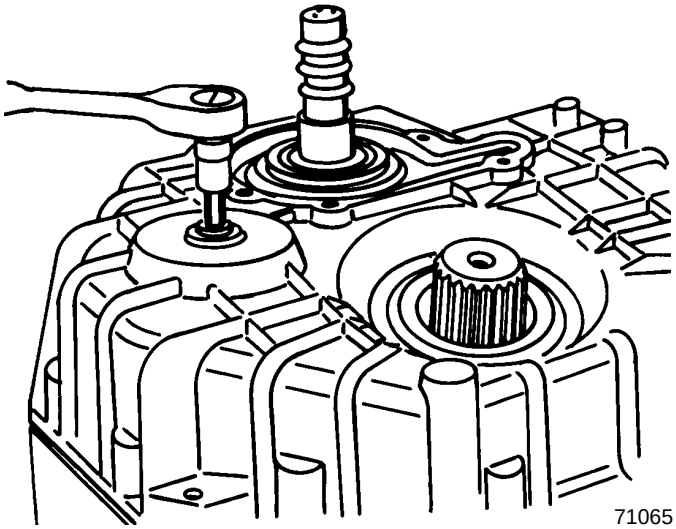
a - Locator Pins
b - Machined Surface

4. Install bolts and lockwashers and torque to 36 lb. ft. (49 N·m).



5. Double check to ensure that there is no shaft clearance on all three shafts. Refer back to previous steps if necessary, and use dial indicator.

6. Remove intermediate shaft hex plug. Apply a drop of Quicksilver Loctite 8831 to threads and reinstall in housing. Tighten securely.



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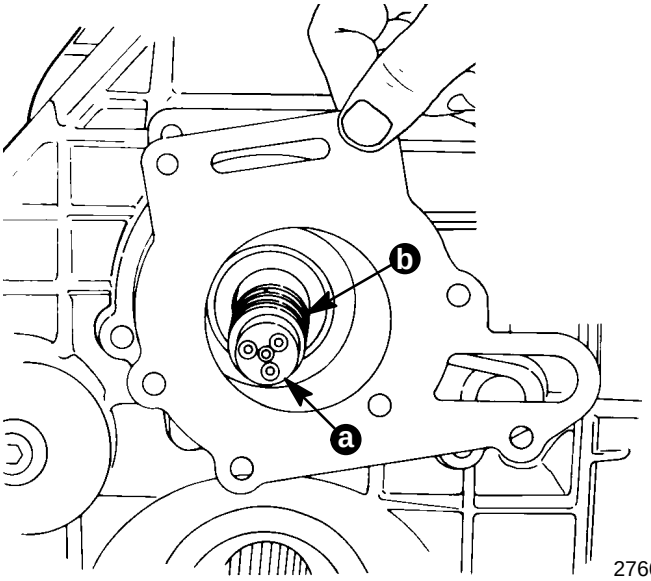
CONTROL BLOCK

1. Ensure piston rings are in place and the key is in keyway. Align key on shaft with keyway in control block.

2. Install new gasket between control block and housing.

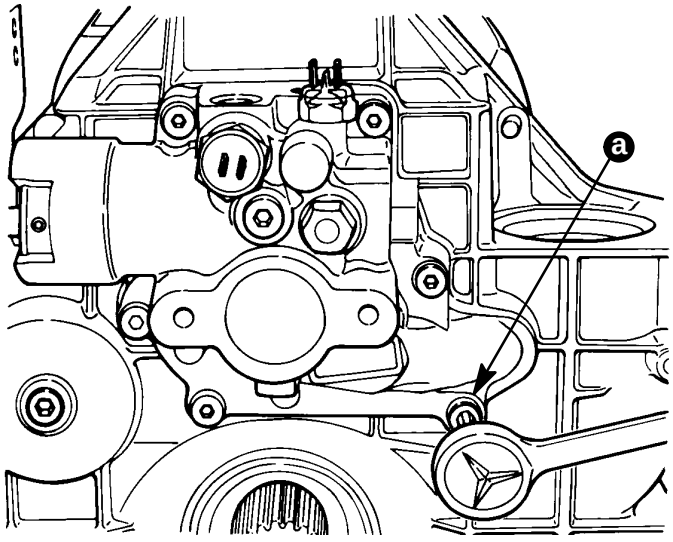


27666

a - Key
b - Piston Rings

3. Carefully push control block onto input shaft.

4. Coat each hex socket head bolt with a drop of Quicksilver Loctite 8831. Secure control block to housing with bolts and lockwashers. Torque to 18 lb. ft. (25 N·m).

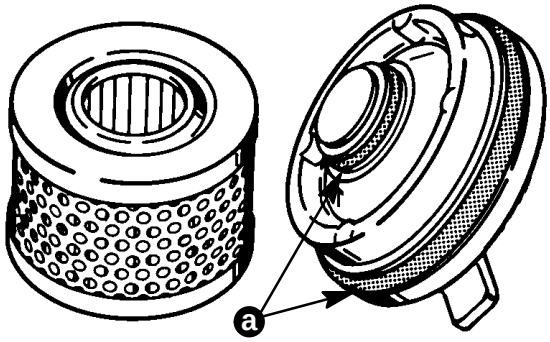


27661

a - Hex Socket Head Bolts (6)

FLUID FILTER

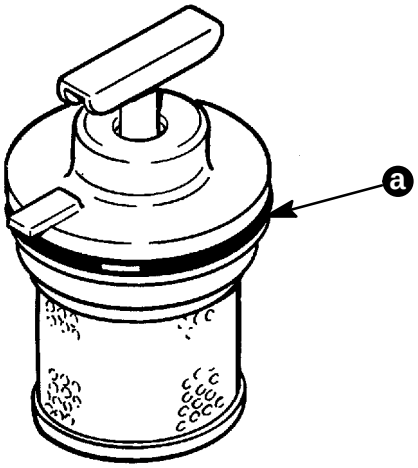
1. Coat new O-rings with ATF.



50975

a - O-Rings

2. Reassemble filter assembly as shown. DO NOT tighten and compress upper O-ring.



72805

a - O-Rings

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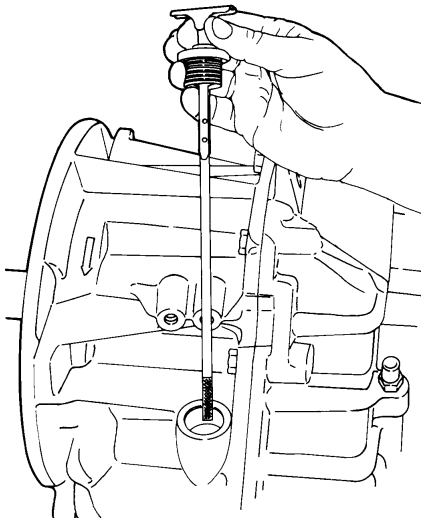
DIPSTICK

1. Coat sealing ring on dipstick with ATF.

2. Install dipstick into transmission and tighten by pressing down and turning clockwise at the same time.



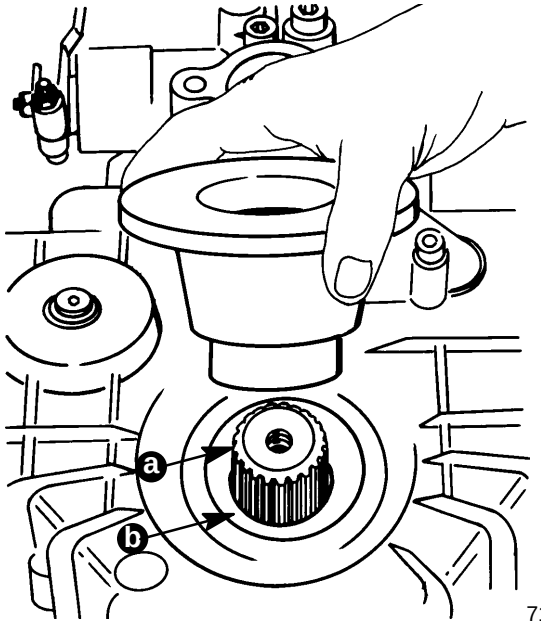
27661

OUTPUT FLANGE

1. Coat output shaft splines with a thin coat of Quicksilver Engine Coupler Spline Grease.

2. Coat lip of output shaft seal with ATF.

3. Install output shaft flange. Be careful not to damage output shaft seal.

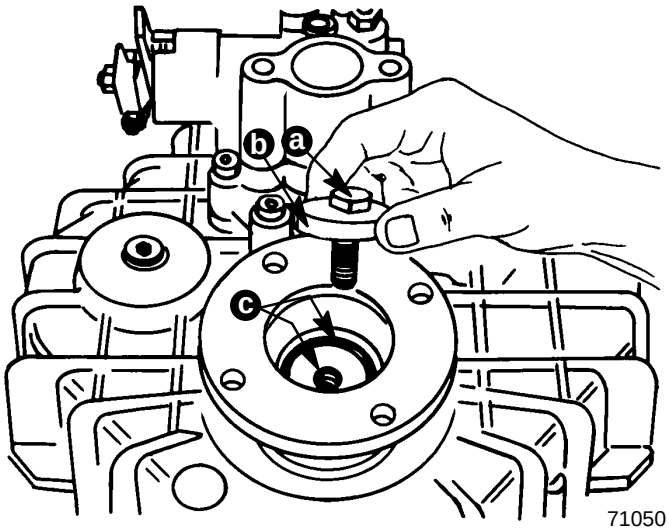


71052

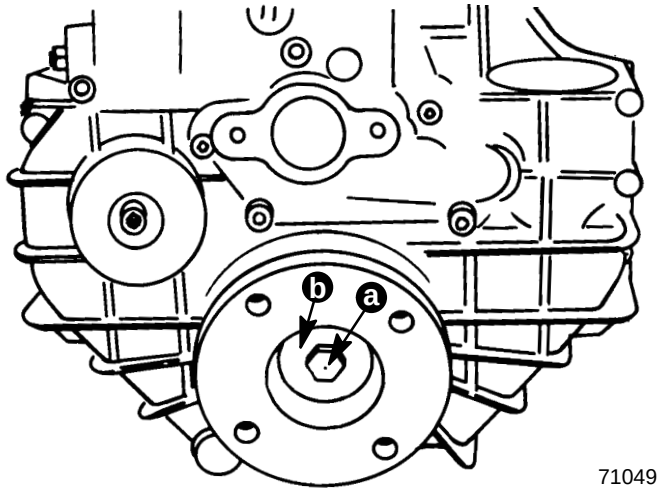
a - Splines
b - Output Shaft Seal

4. Install O-ring into flange and coat with ATF.

5. Install washer and bolt. Torque to 63 lb. ft. (85 N·m).



71050



71049

a - Bolt
b - Washer
c - O-Ring

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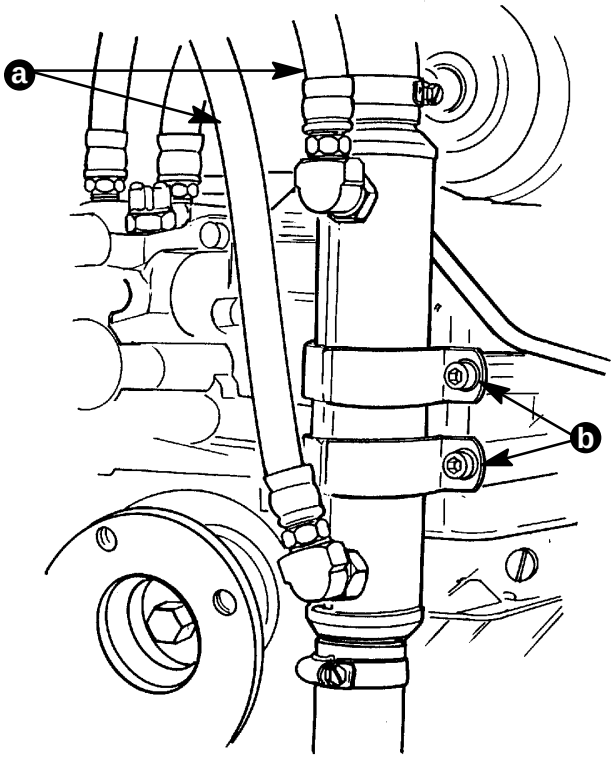
TRANSMISSION FLUID COOLER

1. Install transmission fluid cooler on housing. Secure with clamps and screws as shown. Torque to 18 lb. ft. (25 N·m).

2. Connect transmission fluid hoses to cooler as shown. Tighten securely.



72721

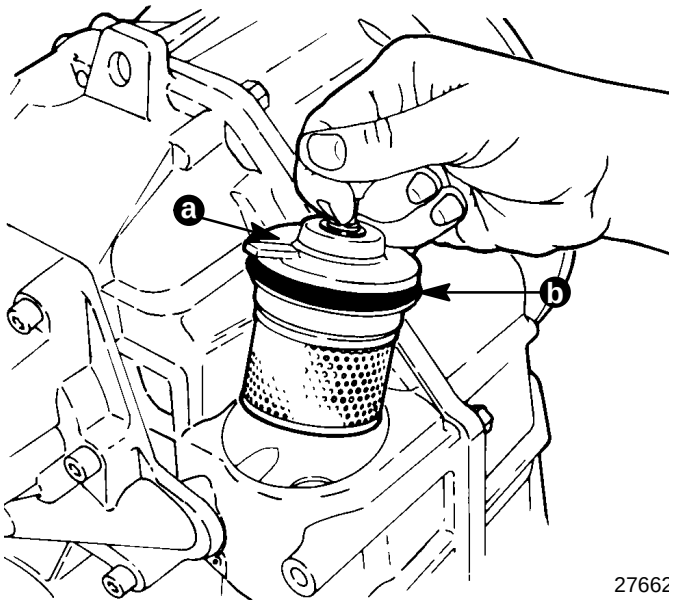
a - Transmission Fluid Hoses
b - Clamps

FILLING WITH TRANSMISSION FLUID

IMPORTANT: Use only ATF (Automatic Transmission Fluid), such as Dexron II-D or III.

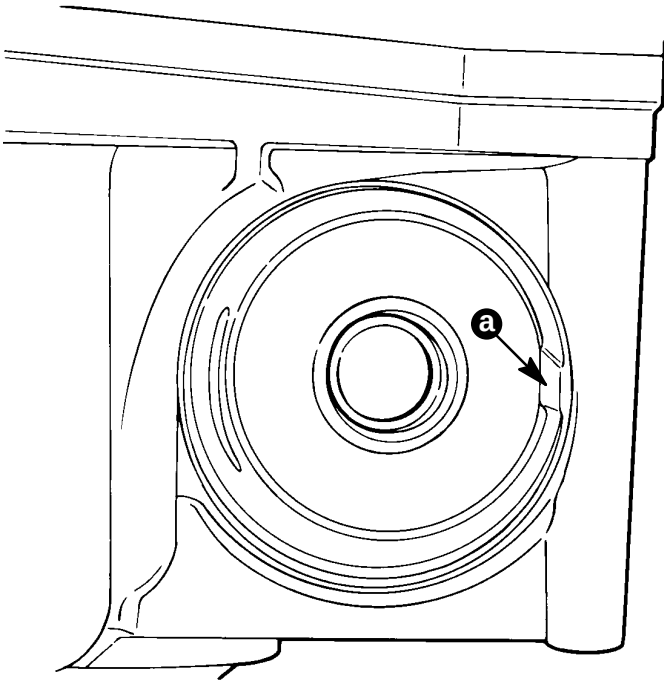
1. Fill transmission to proper level, through fluid filter cavity. (Refer to “Transmission Fluid Capacity”.)

2. Install filter as follows:
   a. Bring flat spot on filter into agreement with flat surface inside of housing.



27662

a - Filter Cover
b - O-Ring

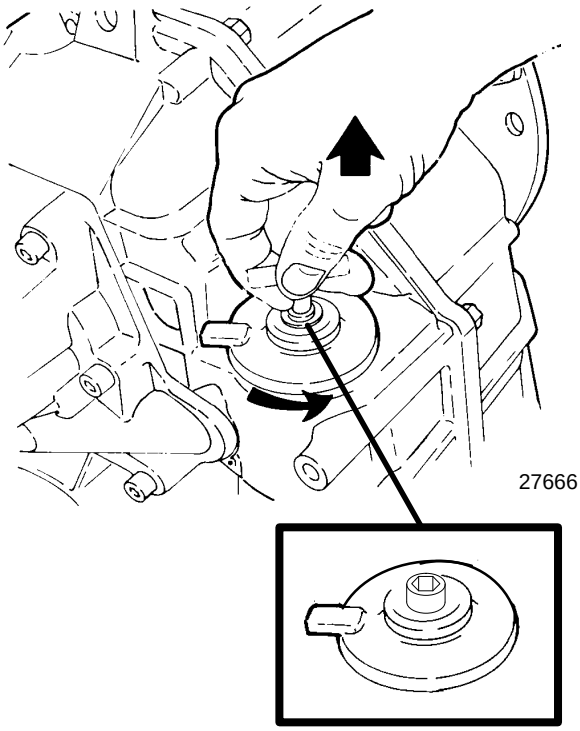


27666

a - Flat Spot

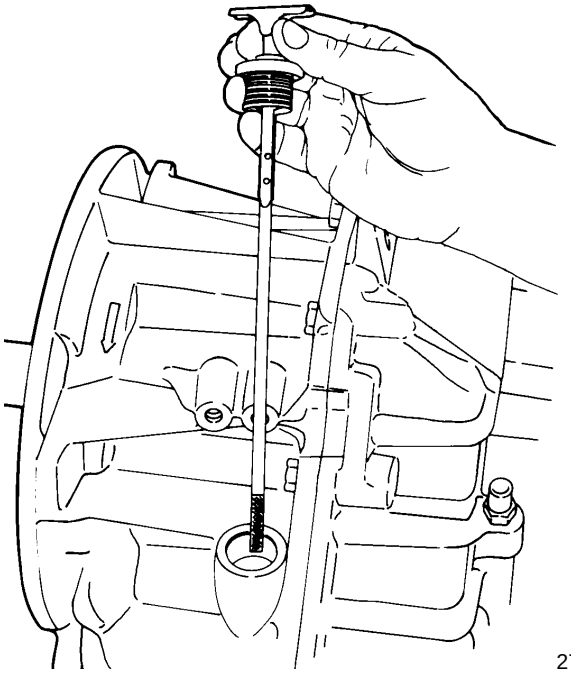
NOTE: *Later model Hurth transmissions have a allen head socket screw on oil filter cover.*

3. Remove oil filter from housing by turning (counterclockwise) and pulling at the same time.



a - Set Screw (Later Models)

4. Check fluid level. Fluid should be between min. and max. marks on dipstick.



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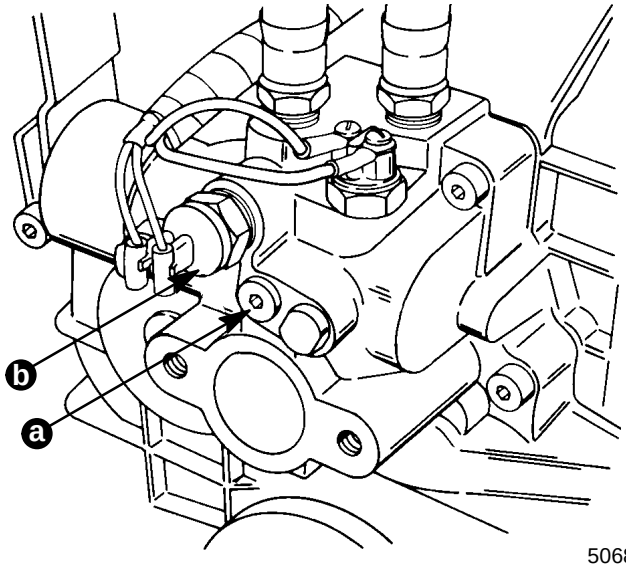
Functional Test

1. Connect a pressure gauge and thermometer to fluid pump at locations shown.



50686

a - Pressure Gauge (m10x1 Thread - Remove Plug)
b - Thermometer (3/8 In. Thread) - Remove Temperature Sender

2. Perform functional tests as shown in chart following. Refer to “Operating Specifications” for correct readings.

Tests to Be Carried Out:

1. Leakages
2. Noise emission
3. Direction of rotation, LH/RH
4. Fluid temperature
5. Shifting pressure

Motor Speed RPM	Shift Lever Position	Duration Minutes	Tests
800-1000	Neutral	5	1 2
600-800 (Idling Speed)	A↔B Position Repeatedly	—	1 2 3
1500-2500	B Position	*	1 2 4
600-800 (Idling Speed)	A↔B Position Repeatedly	—	1 2 3
Idling Maximum Speed	A Position	—	1 2 5**
600 -800	From A → B Position	—	1 2
Idling Maximum Speed	B Position	—	1 2 5**

*Until fluid temperature of 167-176°F (75-80°C) has been reached

**At different speeds

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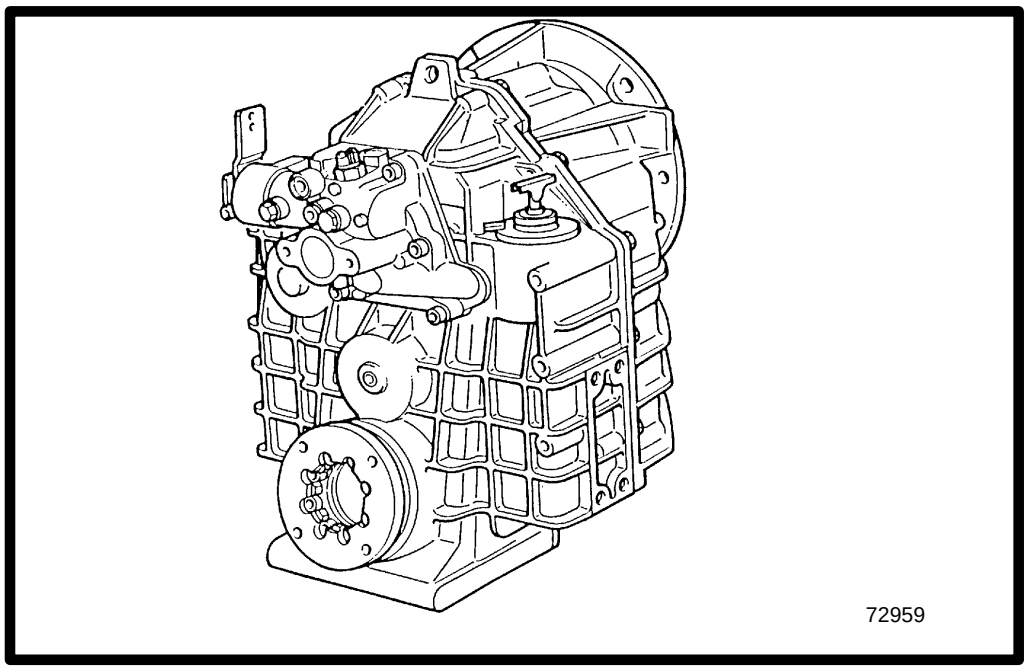
THIS PAGE IS INTENTIONALLY BLANK TO ALLOW FOR CORRECTIONS OR ADDITIONS AT A LATER DATE

DRIVES



HURTH V-DRIVE TRANSMISSION

8

D

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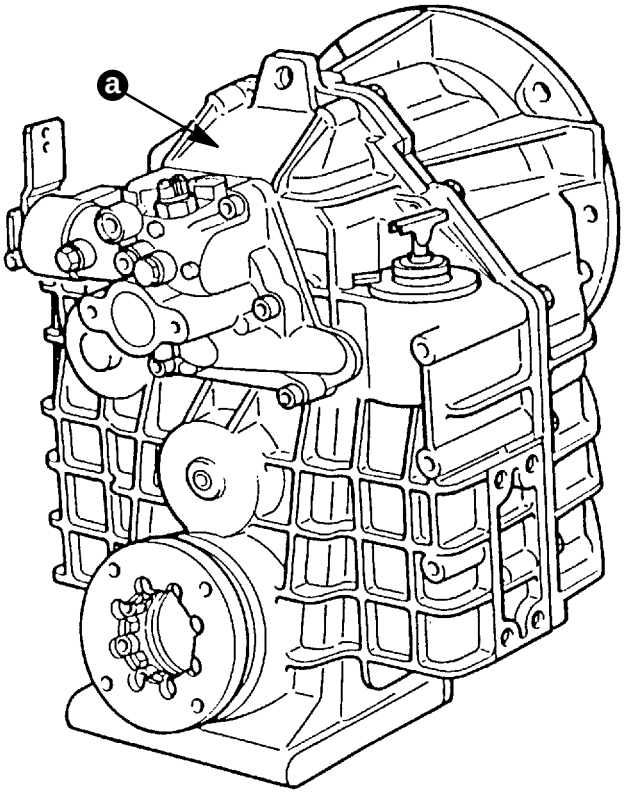
Identification

The transmission identification plate is located on the top rear of the transmission.



72959

HURTH
MÜNCHEN
HSW 630V – 1,5
Getr.-Nr.
i_A = 1,56 i_B = 1,58
MADE IN WEST-GERMANY 71039

Late Style Identification Plate

a - (Stating: Serial Number and Gear Ratio)

Torque Specifications

Fastener Location	Lb. Ft.	N·m
Transmission Housing Halves Bolts and Nuts	36	49
Control Block To Housing	18	25
Output Flange	14	18
Mounts	50	68
Transmission To Flywheel Housing		

Specifications

Description	Specification
Shifting Pressure	312-377 PSI (2151-2599 kPa)
Operating Temperature	130°-200°F (54°-94°C)

Lubricants/Sealants

Description	Specification
Quicksilver Engine Coupler Spline Grease	92-816391A4
Quicksilver Liquid Neoprene	92-27511-2
ATF Dexron ll-D or lll	Obtain Locally
Loctite Type A	
Loctite 515	

Capacity

Model	U.S. Qt. (L)
Hurth 630V	5 (4.7)

Always use dipstick to determine exact quantity of fluid required.

Tools/Lubricants/Sealants

Description	Part Number
Tapered Roller Bearing Inner Race Puller	91-813950
Tapered Roller Bearing Outer Bearing Puller	91-813951
Pressure Plate Removal Tool Reversing Clutch	91-813952
Tapered Roller Bearing Inner Race Puller Plate	91-813953
Mandrel - Input Shaft Seal	91-813955
Mandrel - Output Shaft Seal	91-813956
Preload Tool- Input Shaft	91-813957
Preload Tool - Intermediate Shaft	91-816958
Quicksilver Loctite 8831	92-823089-1
Quicksilver Engine Coupler Grease	91-823089-1
Thermometer [(3/8 In, Thread 0-270°F (-18 to -132°C)]	Obtain Locally
Loctite 515 (Split-Line) Sealer	
Pressure Gauge (M10x1 Thread)	

General

The Hurth transmission is a “full power reversing” transmission, allowing a standard (LH rotation) engine to be used for both rotations. Propeller rotation is determined by shift cable attachment at the remote control.

⚠CAUTION

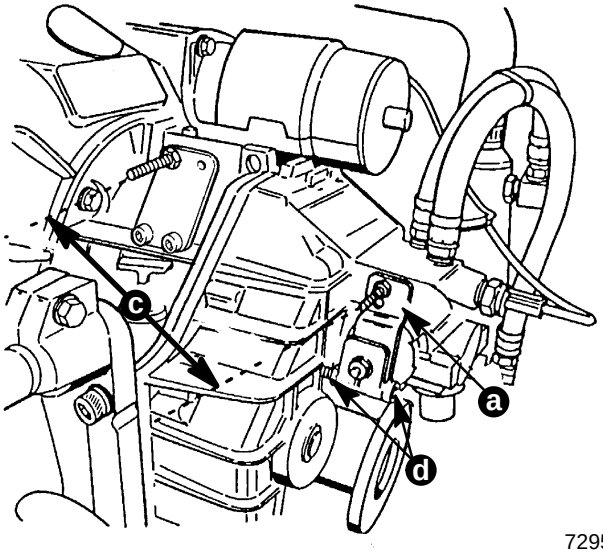
Avoid severe transmission damage. All Hurth Transmissions require Standard Left-Hand rotation engines. NEVER connect a Hurth Transmission to a Right-Hand rotation engine.

IMPORTANT: Transmission propeller rotation is determined by the shift cable installation in the remote control.

- RIGHT-HAND PROPELLER ROTATION - Control cable will have to be installed in remote control so that cable end will move in direction “A” when shift handle is placed in the forward position.
- LEFT-HAND PROPELLER ROTATION - Control cable will have to be installed in remote control so that cable end will move in direction “B” when shift handle is placed in the forward position.

Shift Cable Installation and Adjustment

IMPORTANT: Check that shift lever is positioned approximately 10° aft of vertical as shown when in the neutral detent position and that the distance between studs in the following is set at 7-1/8 in. (181 mm). If necessary, loosen clamping bolt and position lever so that dimension (c) is as shown when in the neutral detent position, and retighten clamping bolt.



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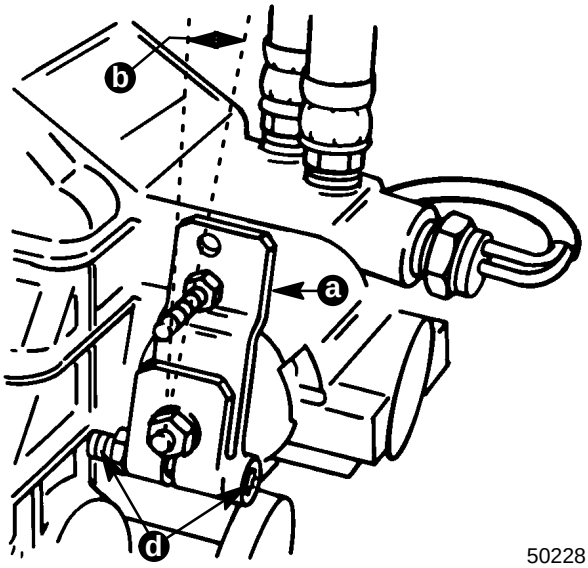


50228

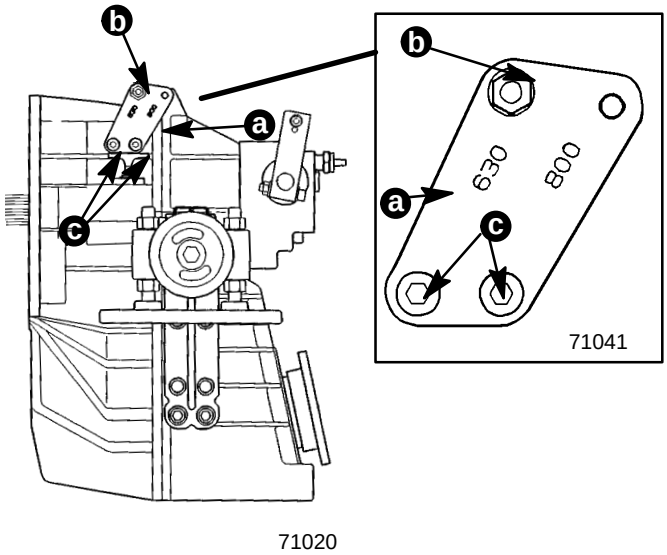
Typical Hurth Transmission Shown

a - Shift Lever
b - Lever, In Neutral Detent, Must Be Approximately 10 Degrees Aft Of Vertical
c - Dimension Between Studs - 7-1/8 In. (181 mm)
d - Clamping Bolt

1. **On bracket with two anchor location holes:** Be certain anchor stud is installed in the hole marked “630.”

⚠WARNING

Avoid serious personal injury or property damage caused by improper shifting. Anchor stud for shift cable must be installed in the correct hole when using bracket with two anchor location holes.



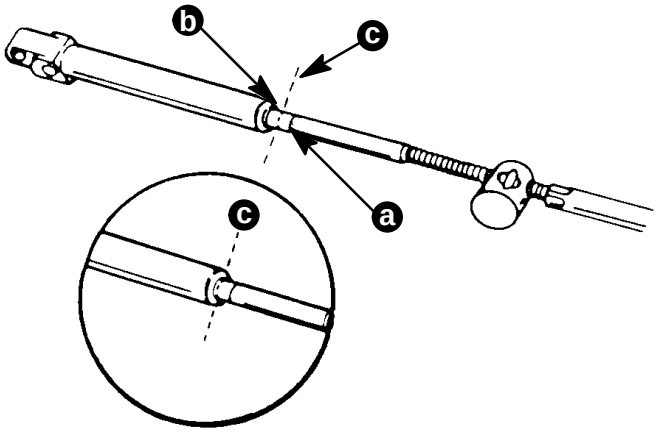
71041

71020

Shift Cable Bracket - Anchor Stud Position Shown for 630 Transmission

a - Shift Cable Bracket
b - Shift Cable Anchor Stud
c - Bracket To Transmission Fasteners

2. Place remote control shift lever and transmission shift lever in neutral position.
3. Remove nuts and washers from shift cable attaching studs.
4. Locate center of remote control and control shift cable play (backlash), as follows:
   a. Check that remote control is in neutral position.
   b. Push in on control cable end with enough pressure to remove play and mark position (a) on tube.
   c. Pull out on control cable end with enough effort to remove play and mark position (b) on tube.
   d. Measure distance between marks (a) and (b), and mark position (c), halfway between marks (a) and (b).

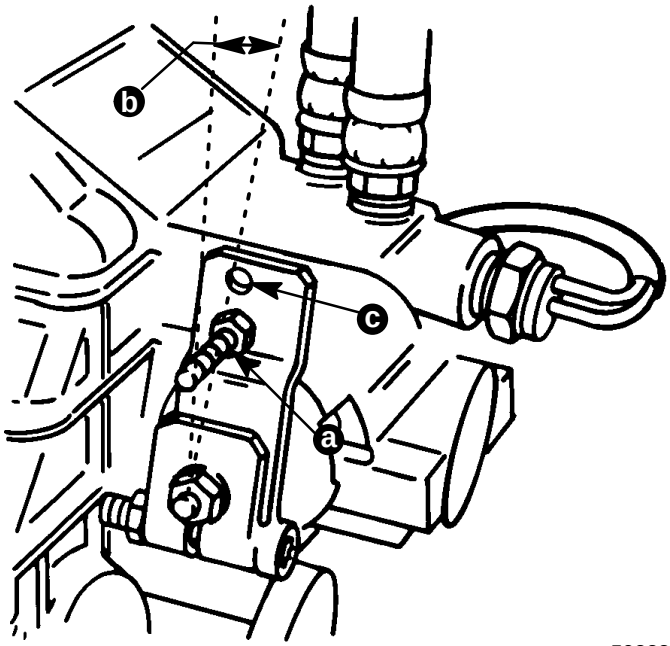


22024

5. Center cable-end play, then adjust cable barrel to align holes in barrel and in cable end guide with attaching points on transmission.
6. Temporarily install shift cable. Do not secure at this time.

IMPORTANT: Transmission is fully in gear when shift lever comes to a stop, in either direction.

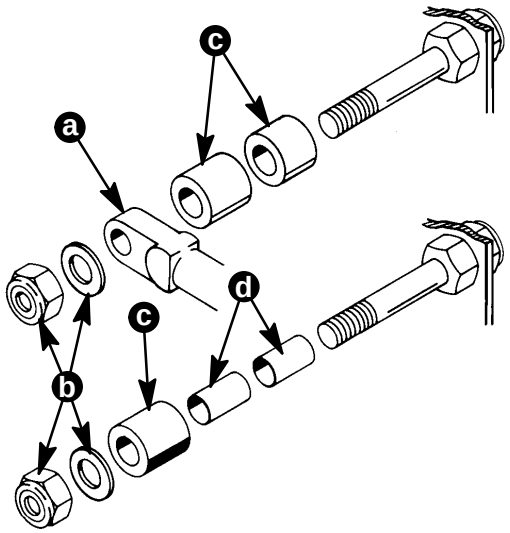
7. Place remote control shift lever in forward gear position. Check to ensure transmission is fully in gear, as follows:
   a. Hold shift lever in position.
   b. Carefully slide shift cable off of anchor points.
   c. Attempt to move shift lever further.
8. Place remote control shift lever in reverse gear position and again check to ensure transmission is fully in gear as follows:
   a. Hold shift lever in position.
   b. Carefully slide shift cable off of anchor points.
   c. Attempt to move shift lever further.
9. If transmission shift lever will position properly in one gear, but not in the other, recheck shift cable adjustment. If transmission shift lever will not position properly in both gears, move transmission shift lever stud, from top hole in shift lever, to bottom hole, and recheck for proper positioning. If proper positioning is still not obtained, remote control does not provide sufficient shift cable travel and must be replaced.



50228

a - Shift Lever Stud (In Bottom Hole, If Required)
b - Lever, In Neutral Detent, Must Be Approximately 10 Degrees Of Vertical
c - Shift Lever Top Hole

10. Install nut and washer to cable end guide stud. Tighten until snug, then back off one full turn.
11. Install nut and washer to cable barrel stud. Tighten until they bottom out. Tighten securely, but do not over- tighten.



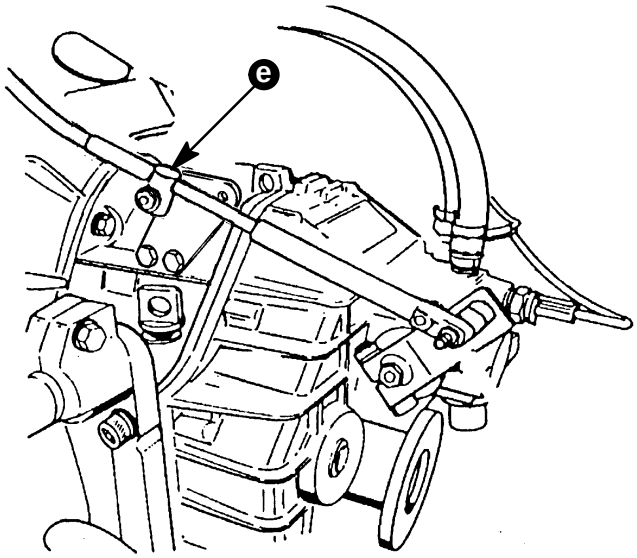
50229

a - Cable End Guide
b - Locknut and Washer (Tighten Until Bottoms Out, Then Back Off 1/2 Turn)
c - Spacer
d - Bushings
e - Cable Barrel

12. Once shift cable adjustment is correct, secure shift cable(s) with hardware as shown, referring to appropriate configuration following:

NOTE: *To change cable approach direction on single or dual station installations, only the spacer/bushings have to be switched to the opposite stud (the studs are identical).*

SINGLE CABLE - FORWARD ENTRY



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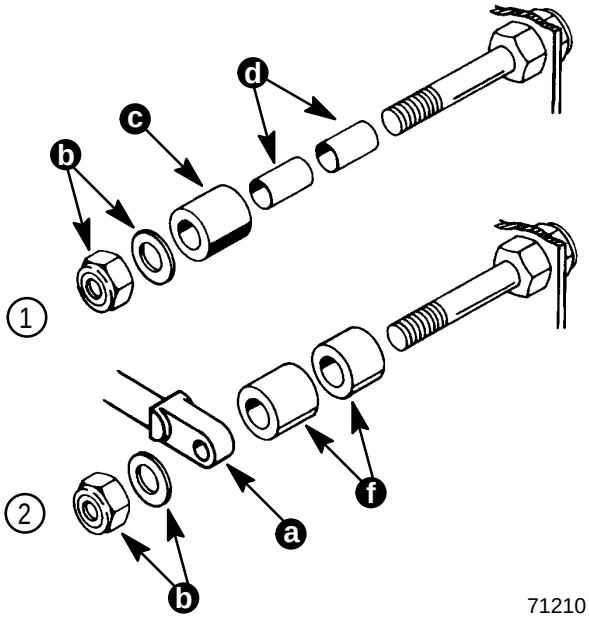
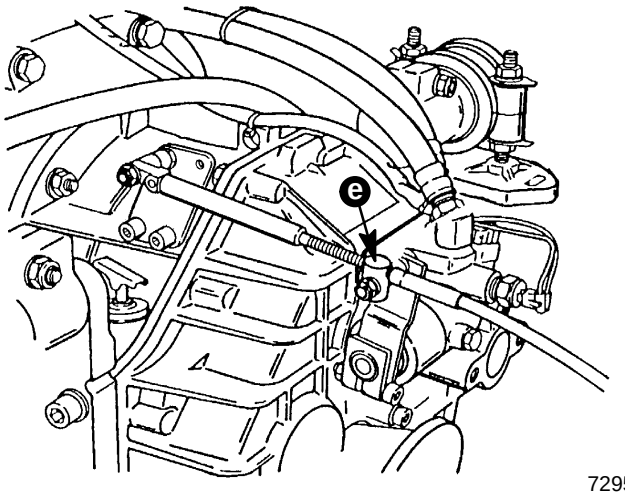


71210

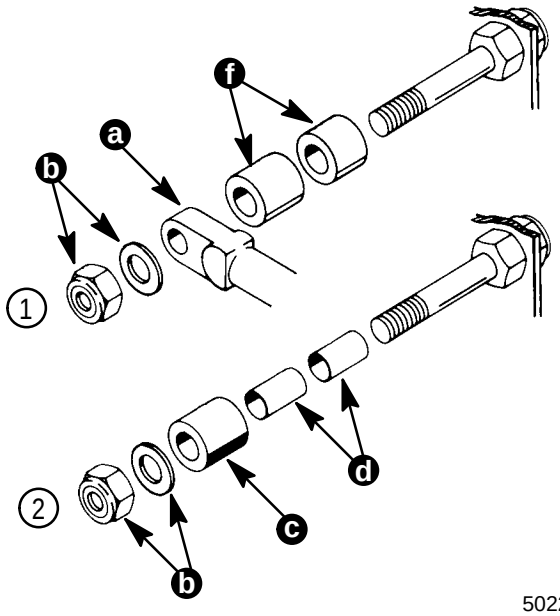
1 - Cable Barrel Stud
2 - Cable End Guide Stud

a - Cable End Guide
b - Locknut and Washer (Tighten Until Bottoms Out, Then Back Off 1/2 Turn)
c - Spacer (Fits Over Bushings)
d - Bushing
e - Cable Barrel
f - Spacers (Fits Over Stud)

SINGLE CABLE - REAR ENTRY



72957

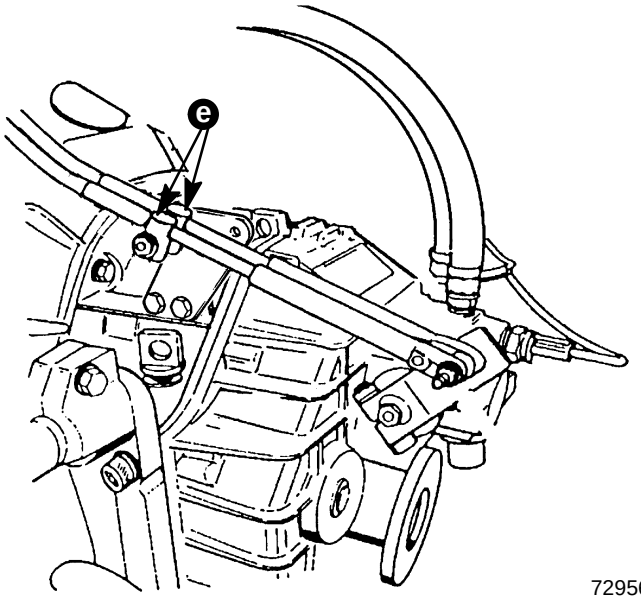


50229

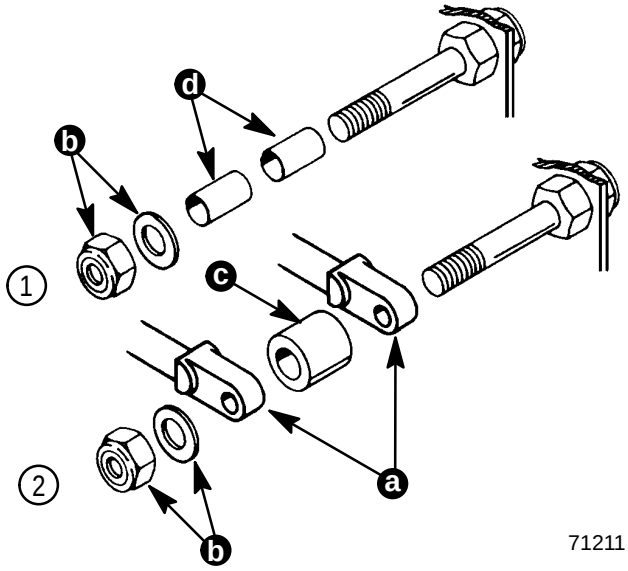
1 - Cable Barrel Stud
2 - Cable End Guide Stud

a - Cable End Guide
b - Locknut and Washer (Tighten Until Bottoms Out, Then Back Off 1/2 Turn)
c - Spacer (Fits Over Bushings)
d - Bushing
e - Cable Barrel

DUAL CABLE - FORWARD ENTRY



72956

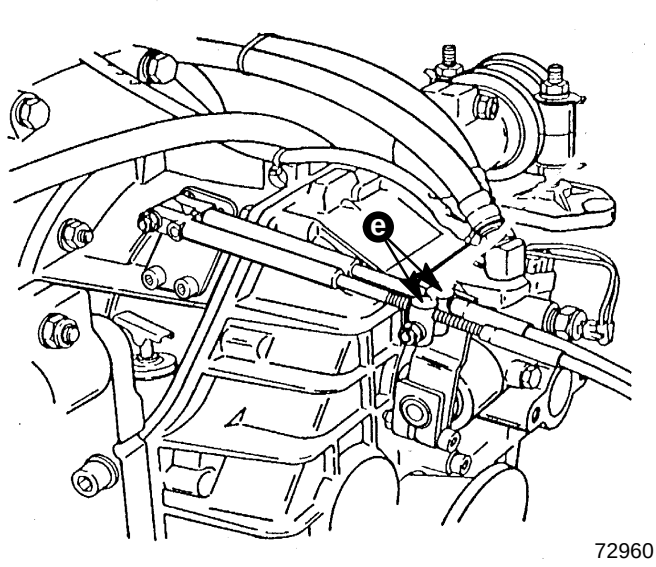


71211

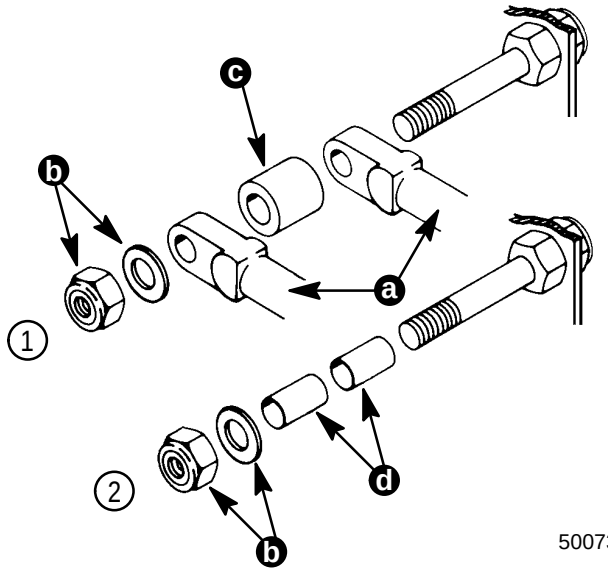
a - Cable End Guide
1 - Cable Barrel Stud
2 - Cable End Guide Stud

a - Cable End Guide
b - Locknut and Washer (Tighten Until Bottoms Out, Then Back Off 1/2 Turn)
c - Spacer (Fits Over Bushings)
d - Bushing
e - Cable Barrel
f - Spacers (Fits Over Stud)

DUAL CABLE - REAR ENTRY



72960



50073

1 - Cable Barrel Stud
2 - Cable End Guide Stud

a - Cable End Guide
b - Locknut and Washer (Tighten Until Bottoms Out, Then Back Off 1/2 Turn)
c - Spacer (Fits Over Bushings)
d - Bushing
e - Cable Barrel
f - Spacers (Fits Over Stud)

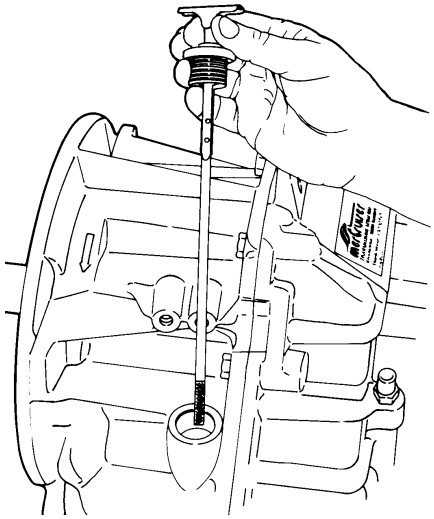
Checking Transmission Fluid Level

IMPORTANT: Use only specified transmission fluid (see "Lubricants/Sealants").

IMPORTANT: The dipstick to check fluid level is located on the port side of transmission. DO NOT remove T-handle on starboard side of transmission.

Check transmission fluid before starting engine each day, as follows:

1. Remove dipstick. Check fluid level as indicated on dipstick. Fluid level may be somewhat over full mark, as some of the fluid from transmission fluid cooler and hoses may have drained back into transmission. If low, add transmission fluid to bring level up to full mark on dipstick.



27661

Typical Hurth Transmission Shown

IMPORTANT: To accurately check fluid level, engine must be run at 1500 RPM for two minutes immediately prior to checking level.

2. Start engine and run at 1500 RPM for two minutes to fill all hydraulic circuits.

IMPORTANT: Be sure to push dipstick all the way down into dipstick tube when checking fluid level.

3. Stop engine and quickly check fluid level. Add automatic transmission fluid, if necessary, to bring level up to full mark on dipstick. (Refer to "Filling Transmission," following.)
4. Reinstall dipstick.

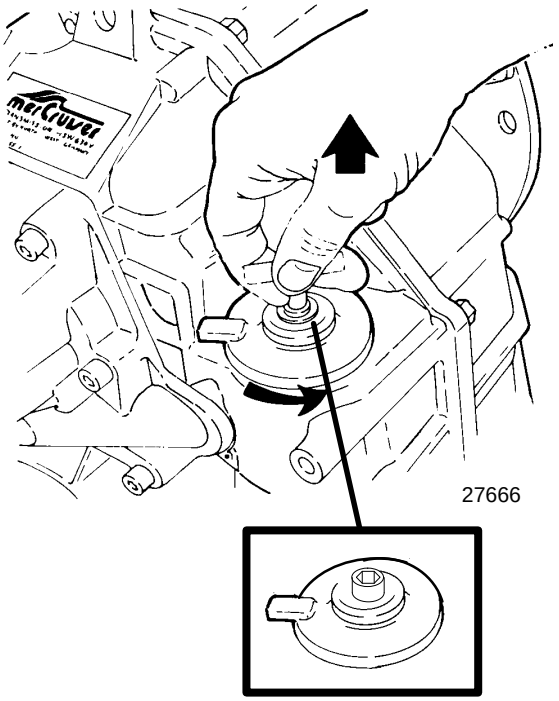
5. If transmission fluid level was extremely low, carefully check transmission, fluid cooler and hoses for leaks.

Draining Transmission

1. Clean the exterior of transmission before disassembly.

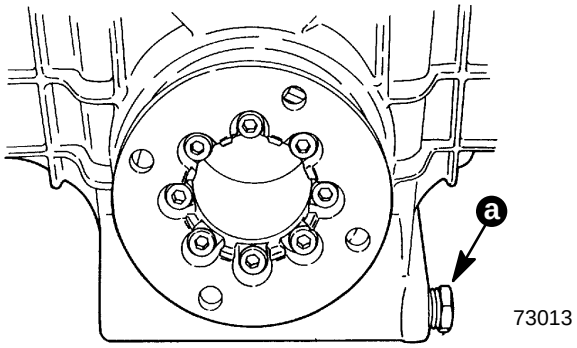
NOTE: *Later model Hurth transmissions will be equipped with an allen head socket screw on the oil filter cover.*

2. Remove oil filter from housing by turning (counterclockwise) and pulling at the same time.



a - Set Screw (Later Models)

3. Remove drain plug from transmission and allow fluid to drain. Reinstall drain plug and tighten securely.

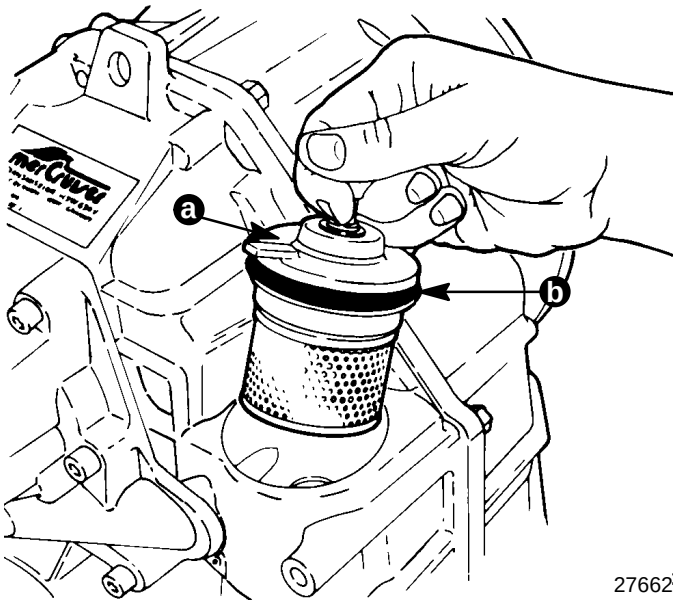


a - Drain Plug

Filling Transmission

IMPORTANT: Use only Automatic Transmission Fluid (ATF) as recommended in "Lubricants/Sealants."

1. Fill transmission to proper level, through oil filter cavity. (Refer to "Capacity.")
2. Install filter as follows:
   a. Coat O-ring on filter cover with transmission fluid.

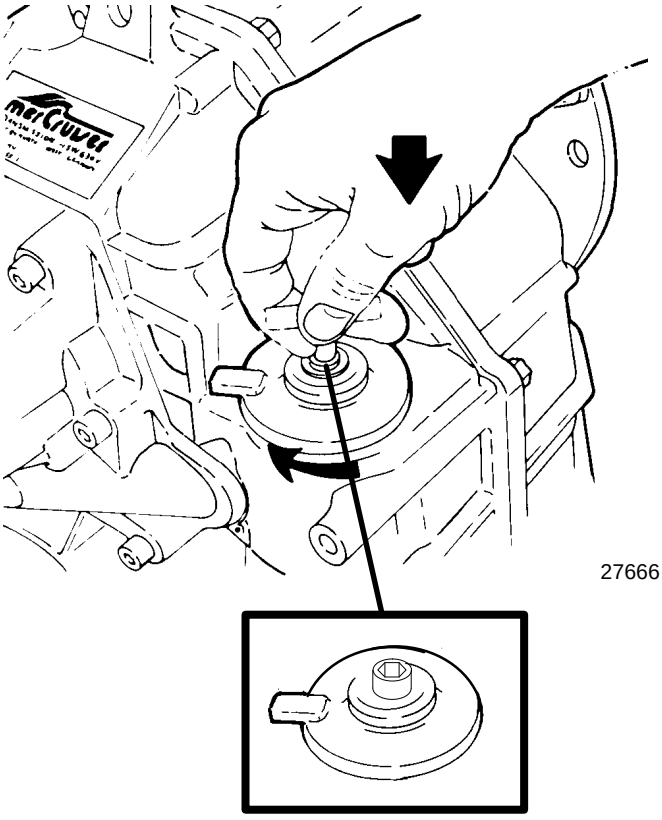


a - Filter Cover
b - O-Ring

⚠CAUTION

Transmission fluid filter and cover must be properly seated to avoid fluid foaming and/or loss of fluid, thus resulting in decreased efficiency and/or damage to transmission.

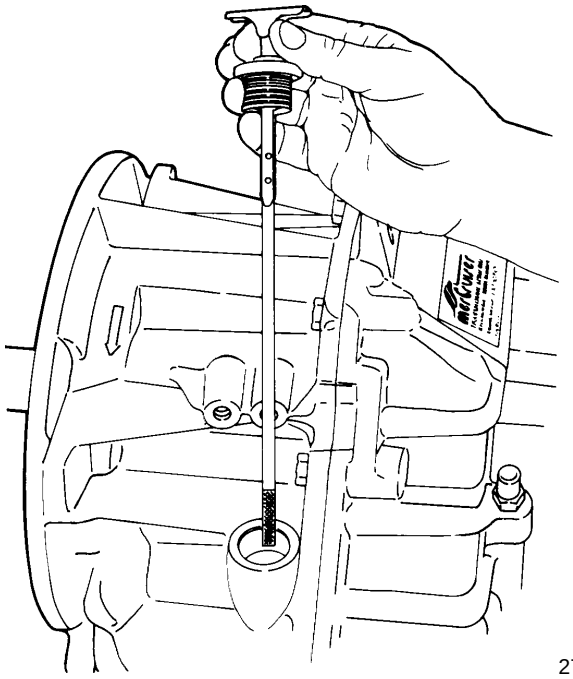
b. Push down until cover is fully seated (top of cover flush with housing), then, Turn T-handle clockwise until tight.



27666

a - Set Screw (Later Models)

3. Start engine and run for two minutes to fill system with fluid.
4. Stop engine and check fluid level. Fluid should be between min. and max. lines on dipstick.

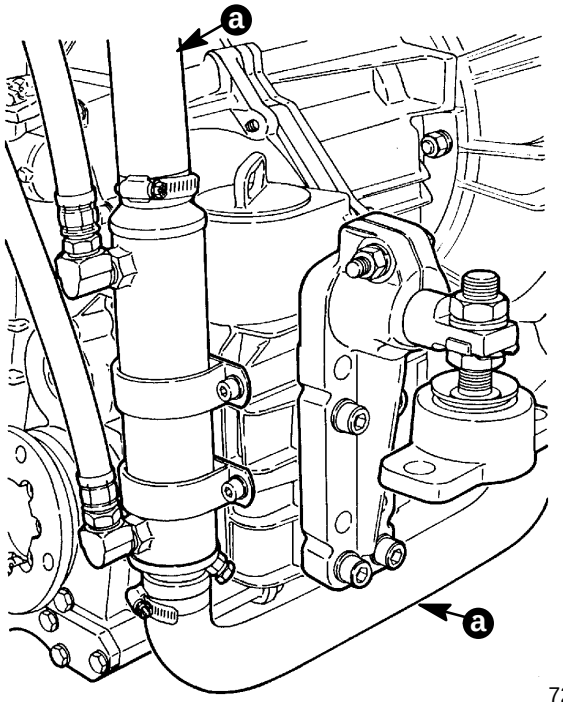


27661

Typical Hurth Transmission Shown

Transmission Removal

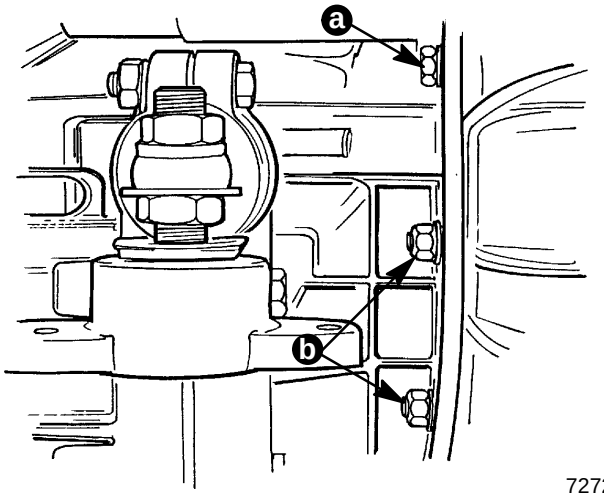
1. Disconnect wires from neutral safety switch and audio warning temperature switch.
2. Disconnect seawater hoses from transmission fluid cooler.



72711

a - Seawater Hoses

3. Remove bolts and locknuts and remove transmission.

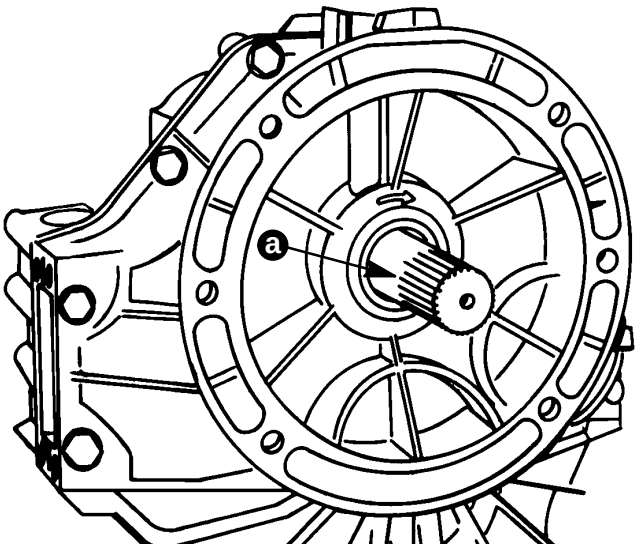


72720

a - Bolts (2), One On Each Side
b - Locknuts (4), Two On Each Side

Transmission Installation

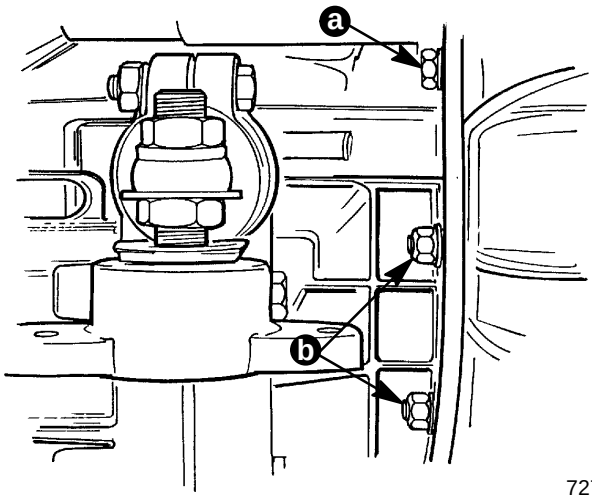
1. Coat splines on input shaft with Quicksilver Engine Coupler Spline Grease.



71044

a - Input Shaft

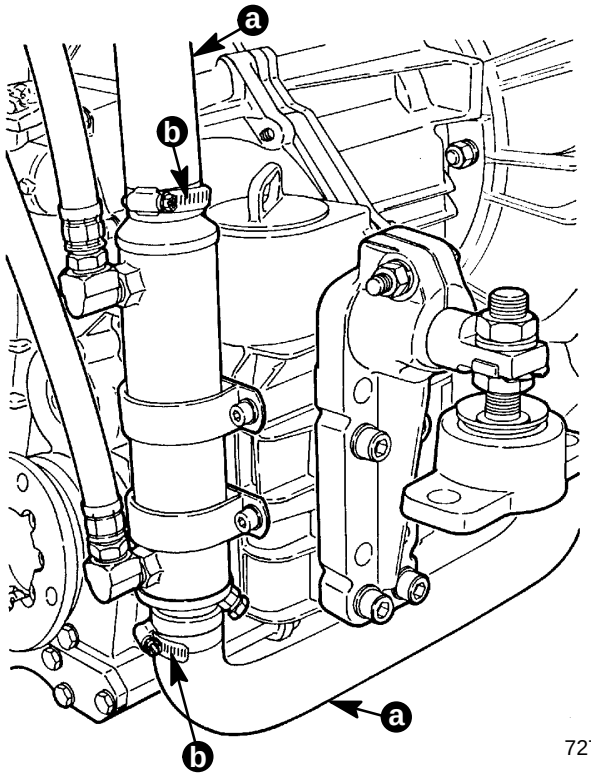
2. Install transmission on flywheel housing and secure with hardware shown. Torque fasteners to 50 lb. ft. (68 N·m).



72720

a - Bolts (2), One On Each Side
b - Locknuts (4), Two On Each Side

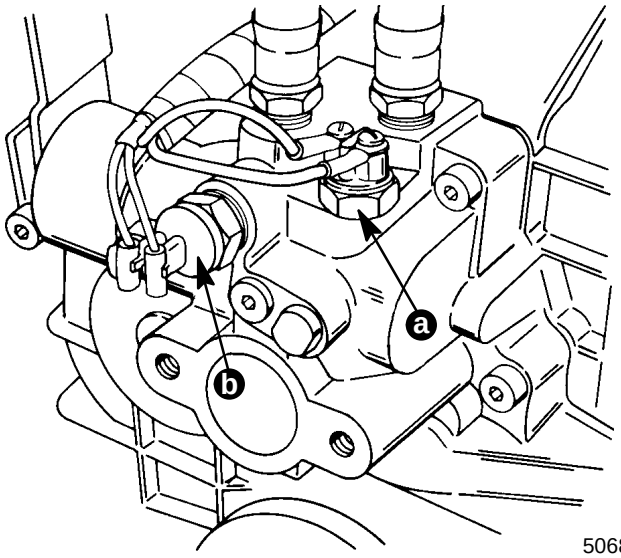
3. Connect seawater hoses to transmission fluid cooler and tighten hose clamps securely.



72711

a - Seawater Hoses
b - Hose Clamps

4. Connect wires to neutral safety switch and to audio warning temperature switch. Coat connections on neutral safety switch with Quicksilver Liquid Neoprene.



50686

a - Neutral Safety Switch
b - Audio Warning Temperature Switch

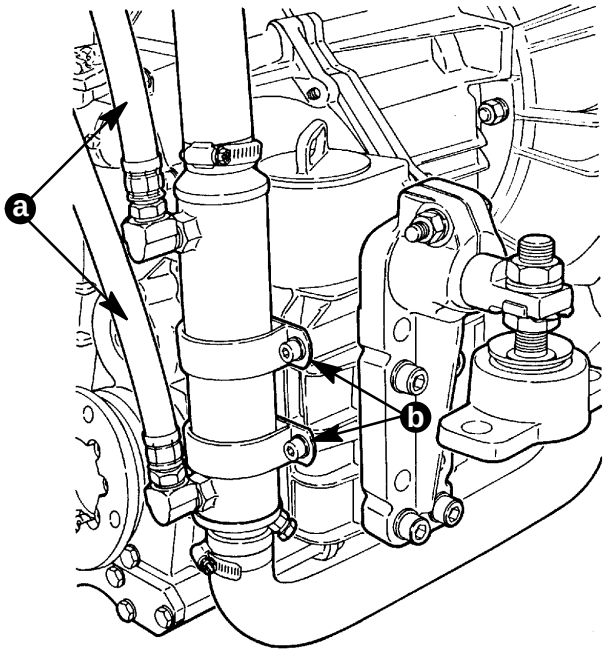
Transmission Repair

Disassembly

IMPORTANT: Ensure work area is clean before disassembly is started. Be sure to use lint free cloths when cleaning and/or handling parts.

TRANSMISSION FLUID COOLER

1. Disconnect transmission fluid hoses from cooler and remove clamps that secure cooler to housing.

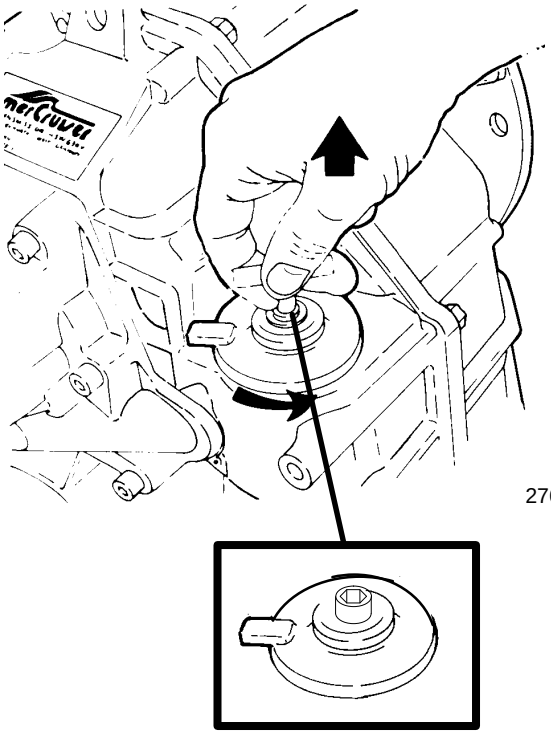


72711

a - Transmission Fluid Hoses
b - Clamps

OIL FILTER AND DIPSTICK

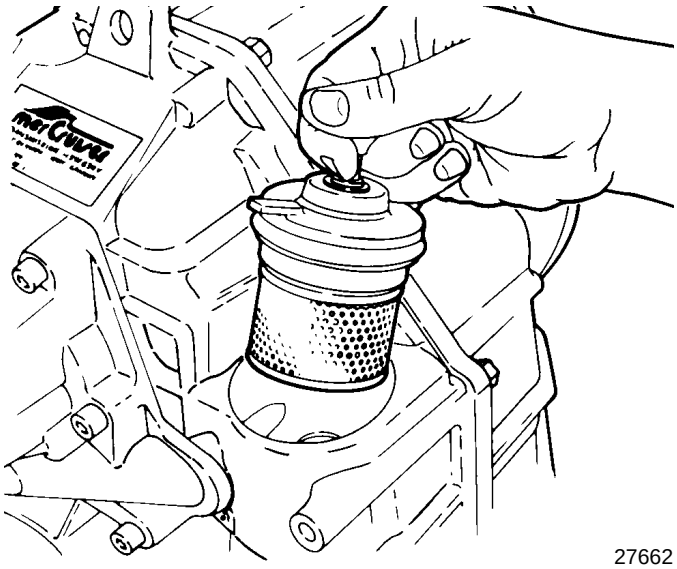
1. Remove oil filter from housing by turning (counterclockwise) and pulling at the same time.



27666

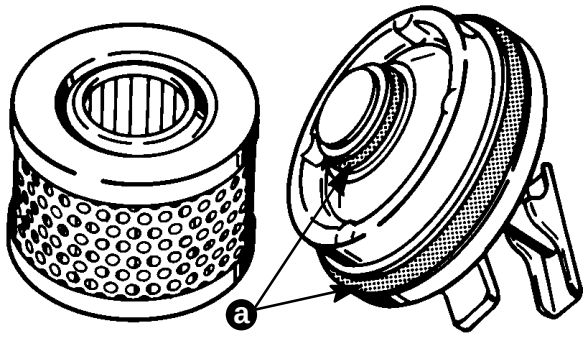
c - Set Screw (Later Models)

2. Remove cover and filter element from transmission.



27662

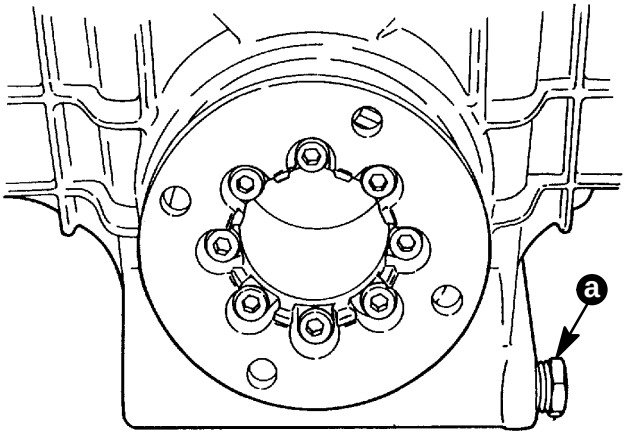
3. Remove filter element from cover and inspect O-rings for wear. Replace if necessary.



50975

a - O-Rings

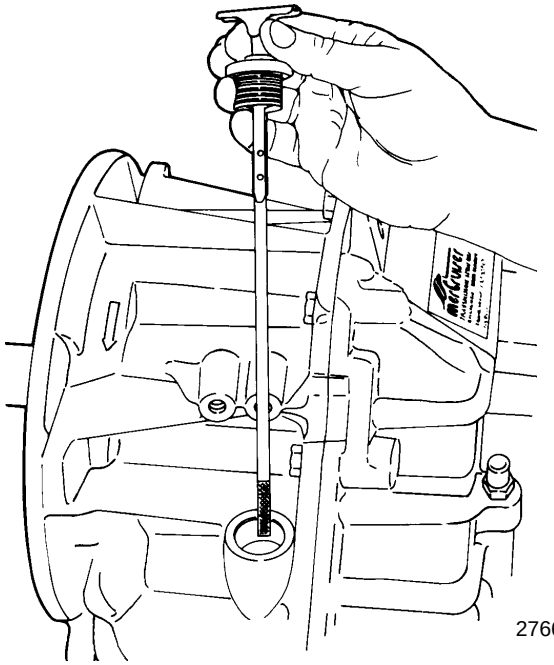
4. Remove drain plug from transmission and allow fluid to drain. Reinstall drain plug and tighten securely.



73013

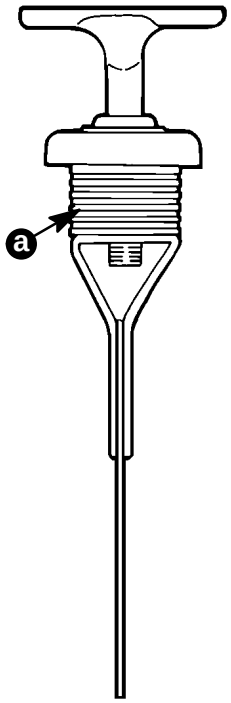
a - Drain Plug

5. Remove dipstick by turning (counterclockwise) and pulling at the same time.



27661

6. Inspect seal for wear and replace if necessary.

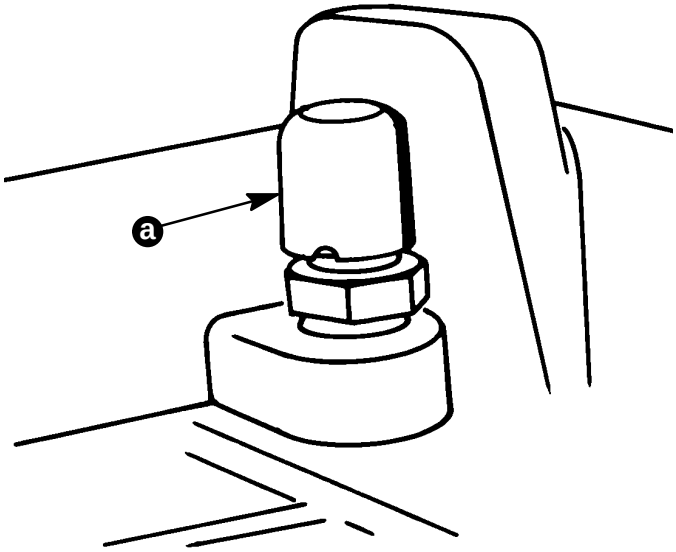


27659

a - Seal

BREATHER VALVE

1. Remove breather valve. Clean with suitable cleaner, allow to dry and coat with oil.

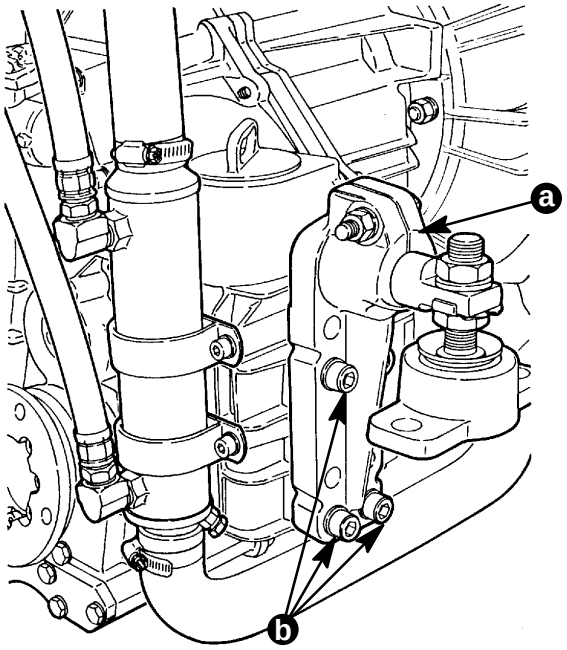


71048

a - Breather Valve

MOUNTS

1. Remove mounts from transmission housing. Inspect mounts for damage and replace if necessary.



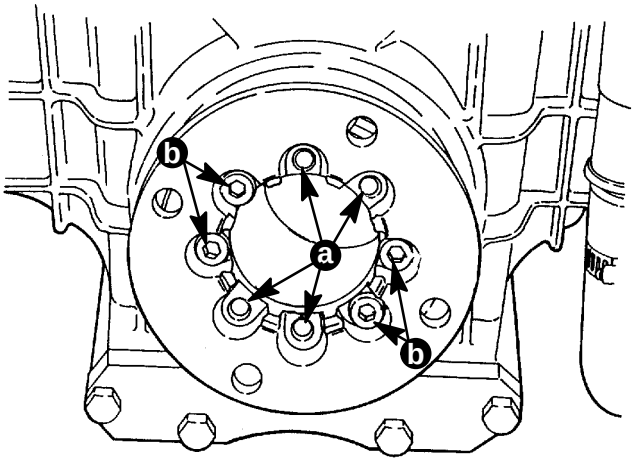
72711

a - Transmission Mount
b - Retaining Screws (4 Total On Each Mount - One Hidden In This View)

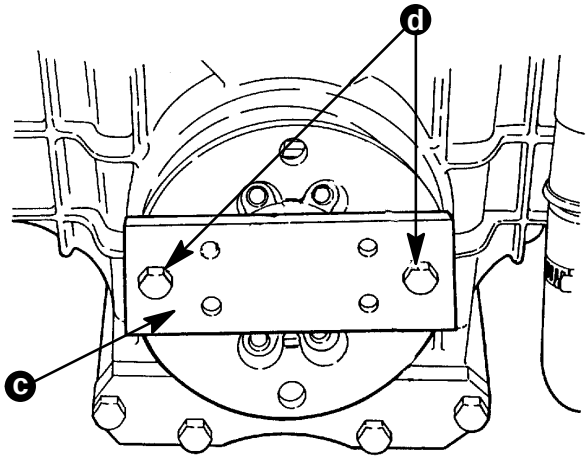
70158

OUTPUT FLANGE

1. Remove four bolts as shown and loosen but DO NOT remove four remaining bolts. Install flange puller plate on output flange and secure with bolts and nuts.



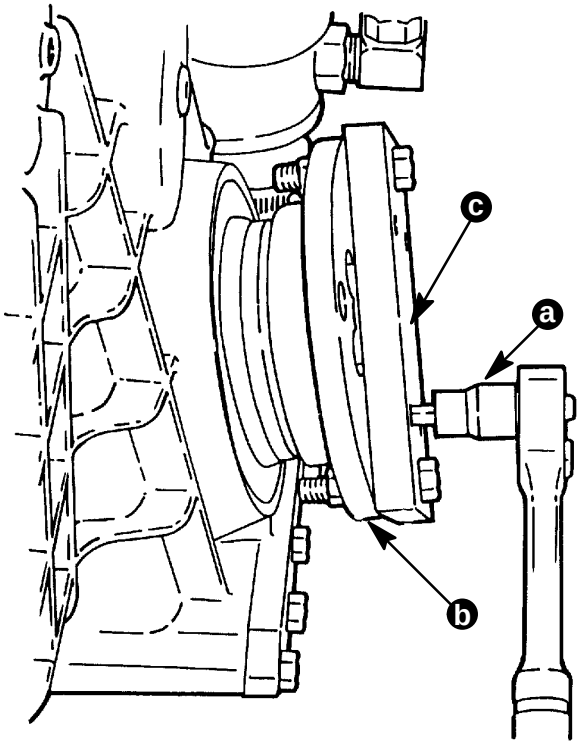
73014



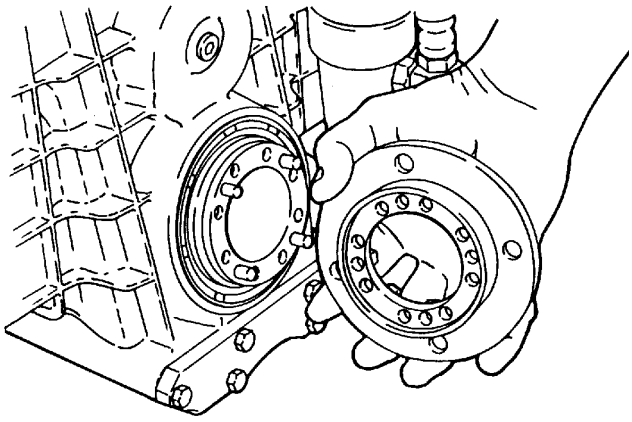
73015

a - Bolts - Remove
b - Bolts - Loosen (DO NOT REMOVE)
c - Flange Puller Plate
d - Bolts and Nuts

2. Turn four remaining bolts out until they just contact flange puller plate. Then continue to turn bolts out evenly (to push on puller plate) to remove flange.



73016

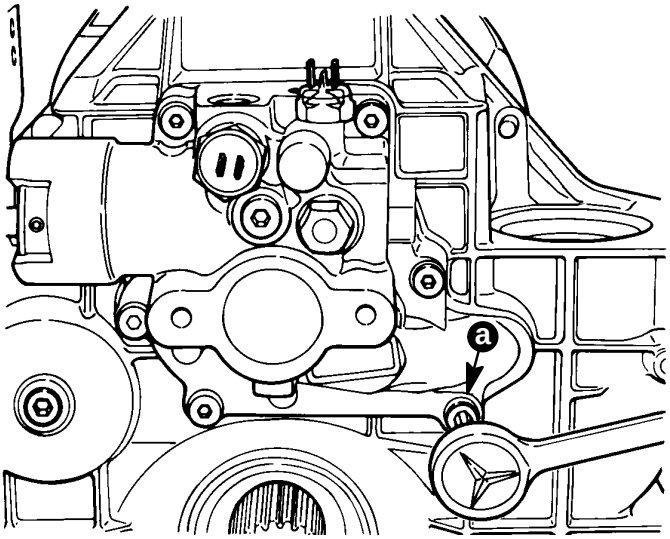


73017

a - Hex Wrench
b - Flange
c - Flange Puller Plate

CONTROL BLOCK

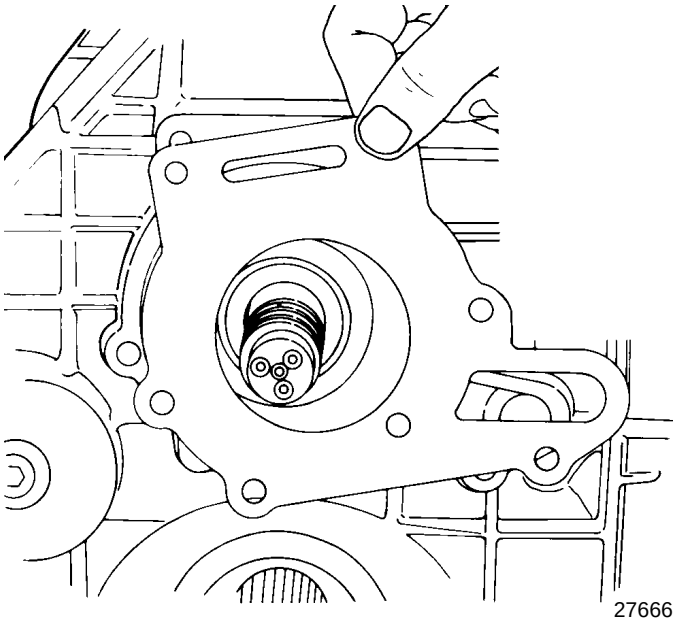
1. Remove hex head bolts.



27661

a - Hex Socket Head Bolts (6)

2. Remove control block and gasket from housing.

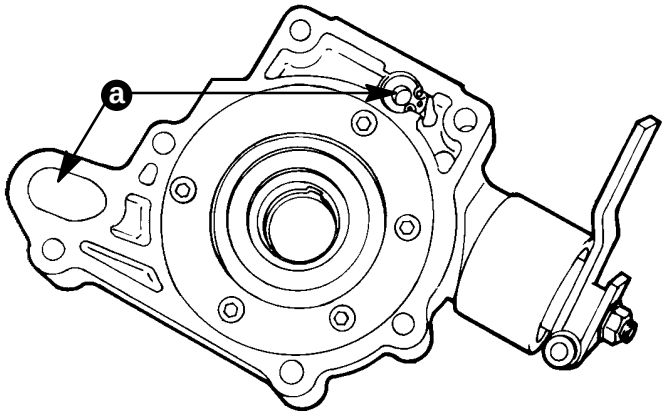


27666

⚠CAUTION

Be careful not to allow dirt to enter control block from front side.

3. Cover openings in control block with a protective cloth.

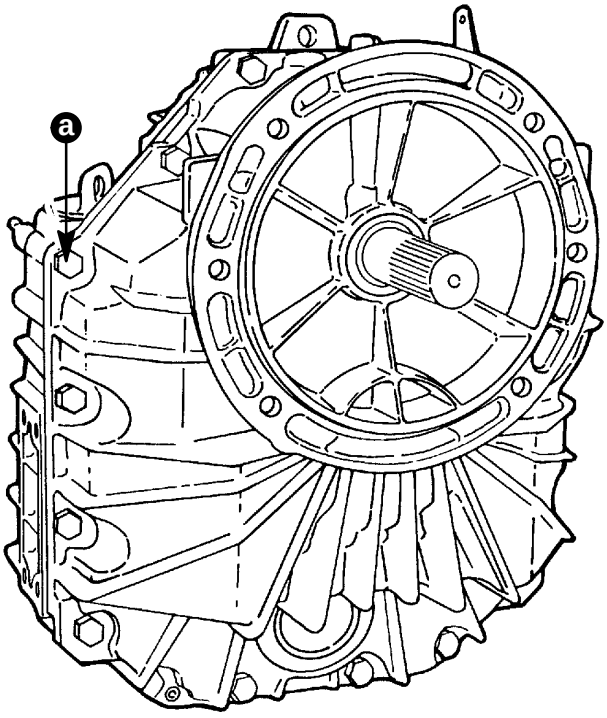


27665

a - Openings

HOUSING

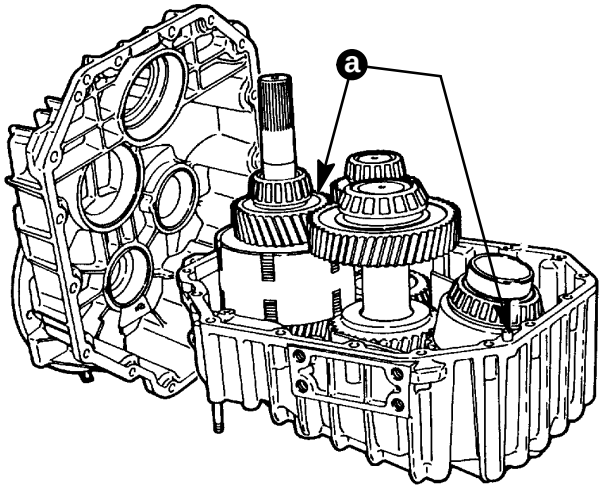
1. Remove hex head bolts from input side of housing.



73018

a - Hex Bolts (16)

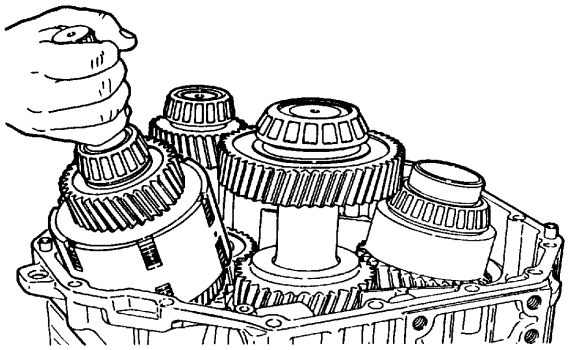
2. Remove input side of housing. Be sure to locate and save locator pins.



73019

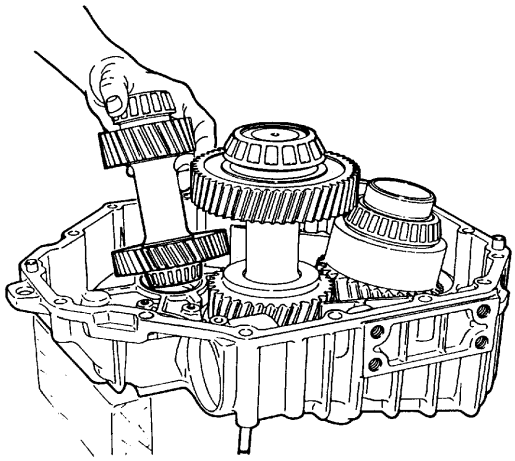
a - Locator Pins

3. Remove input shaft assembly.



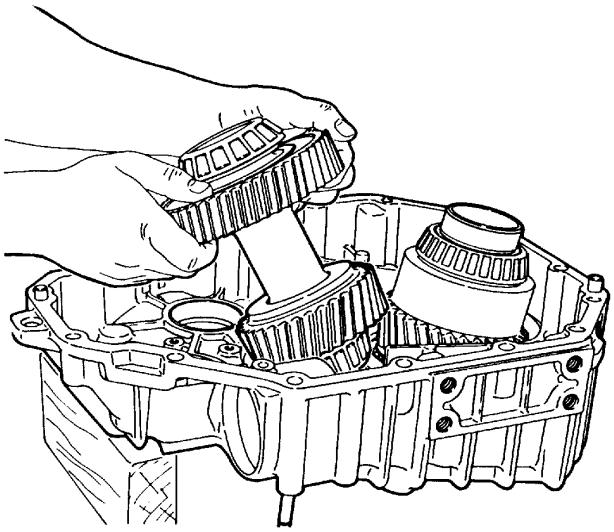
73020

4. Remove intermediate shaft assembly.



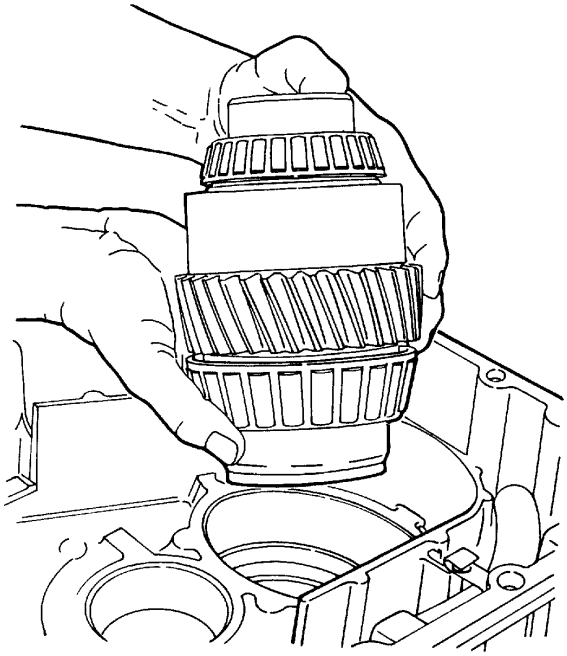
73021

5. Remove reversing shaft assembly.



73022

6. Remove output shaft assembly.



73023

BEARING, GEAR AND SEAL INSPECTION

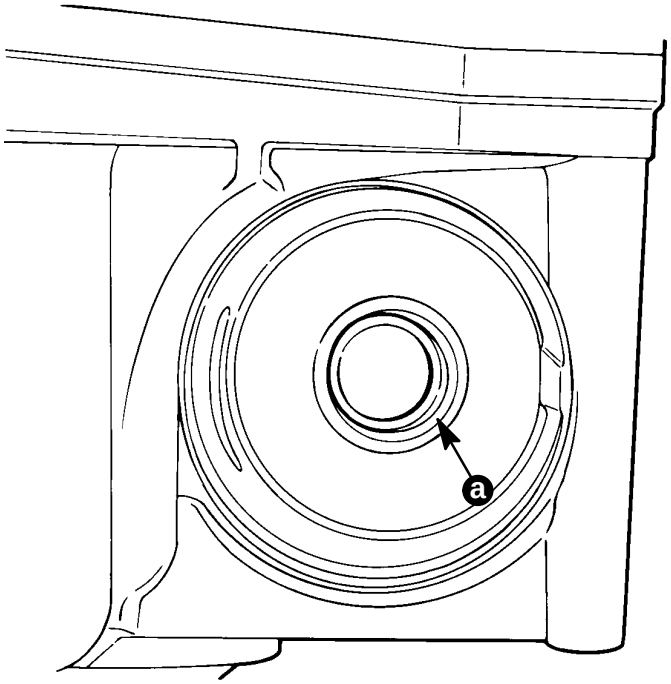
1. Inspect all tapered roller bearings, the piston rings on the input shaft and all gears for wear. If damage has been found on the gearing of the intermediate or output shaft, it is ALWAYS necessary to replace the complete shaft.

   When gears on the input shaft have to be replaced, the tapered roller bearings and needle bearings MUST BE replaced as well.

2. Turn gears of input shaft to check correct operation of the reversing clutch. If it is hard to turn the gears, the clutch is probably damaged.

SEALS

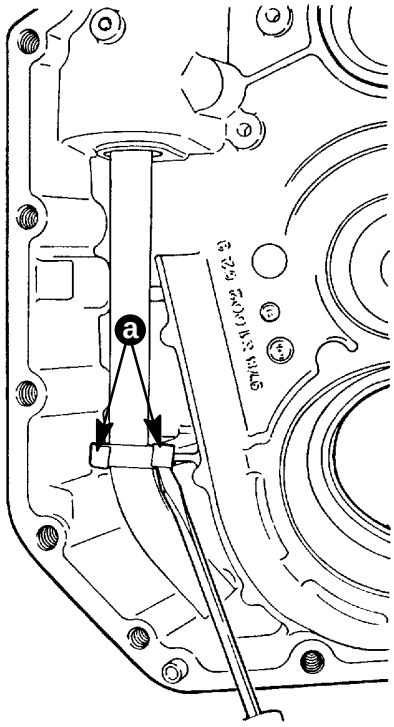
1. Remove suction pipe seal as follows:



27666

a - Seal

a. Bend tabs up away from screws.

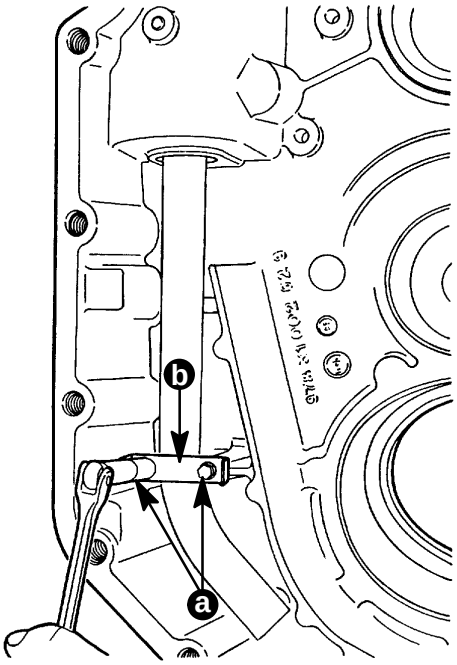


73024

a - Tabs

b. Remove screws and hold down plate.

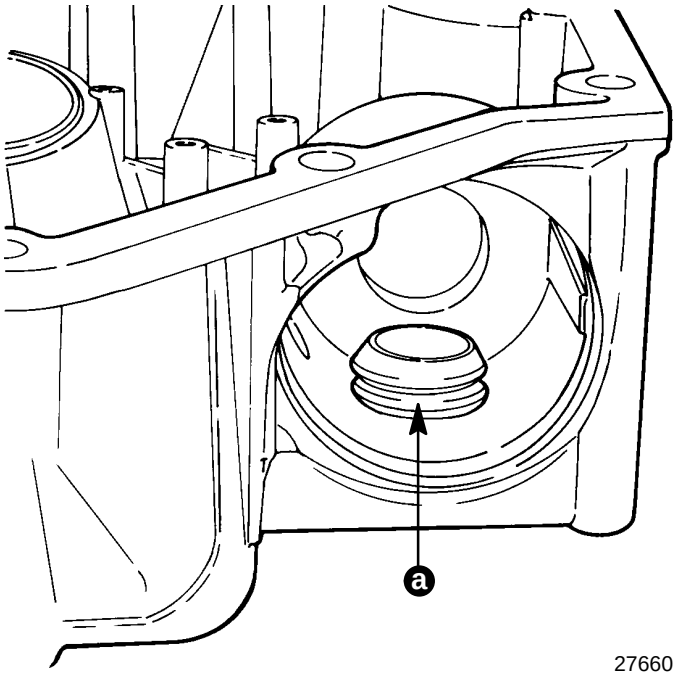
c. Remove suction pipe by pulling downward out of seal.



73025

a - Screws
b - Hold Down Plate

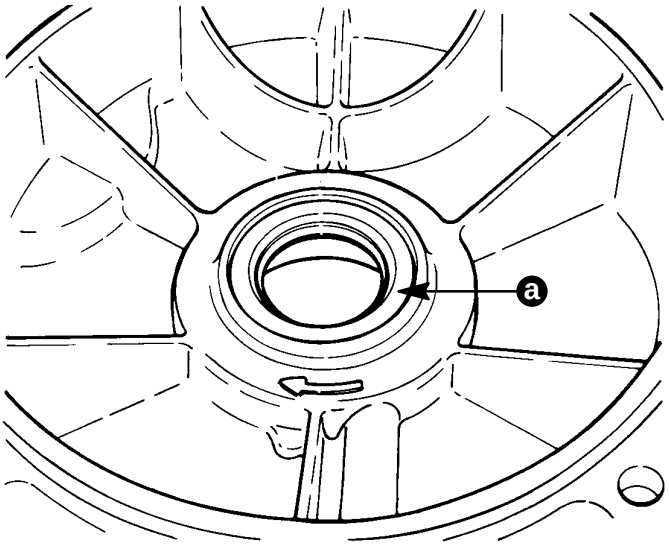
d. Remove seal from top side.



27660

a - Seal

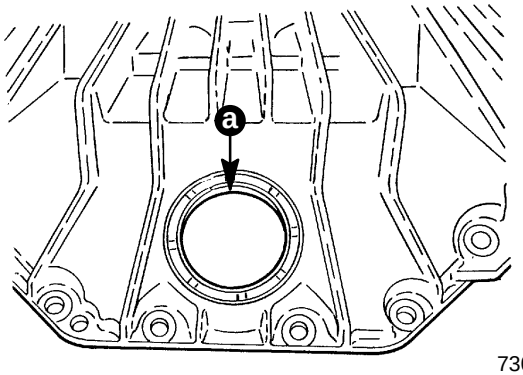
2. Remove input shaft seal using appropriate mandrel.



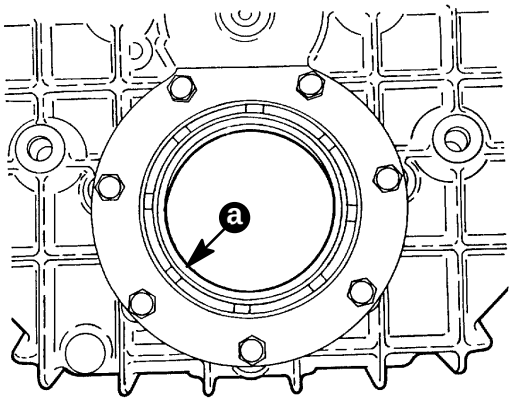
27670

a - Seal

3. Remove output shaft seals using appropriate mandrel.



73026



73027

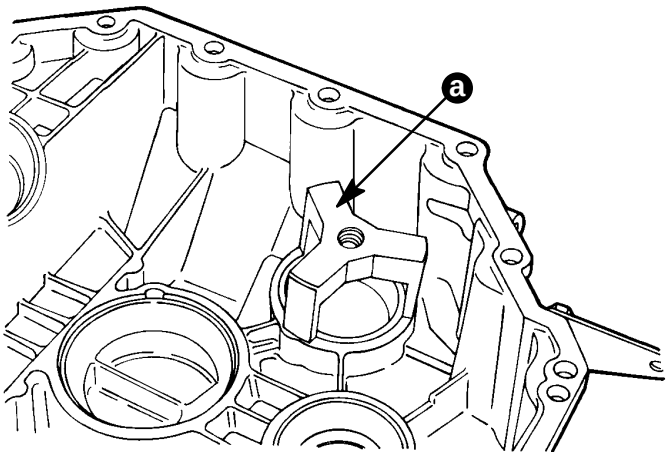
a - Seals

TAPERED ROLLER BEARING CUPS

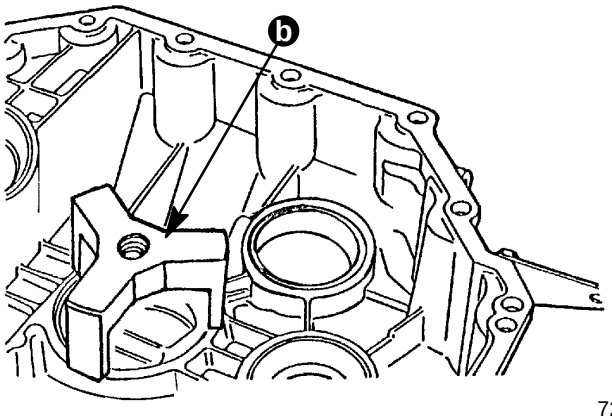
IMPORTANT: Do not remove tapered roller bearing cups unless replacing tapered roller bearings. Bearing and cup must be replaced as a set.

IMPORTANT: Do not mix up shims under cups on the input housing side. Shims are required for adjusting the bearing preload.

1. Pull tapered roller bearing cups from housing using special puller as follows:
   a. Position appropriate puller guide (large diameter or small diameter) over cup as shown.



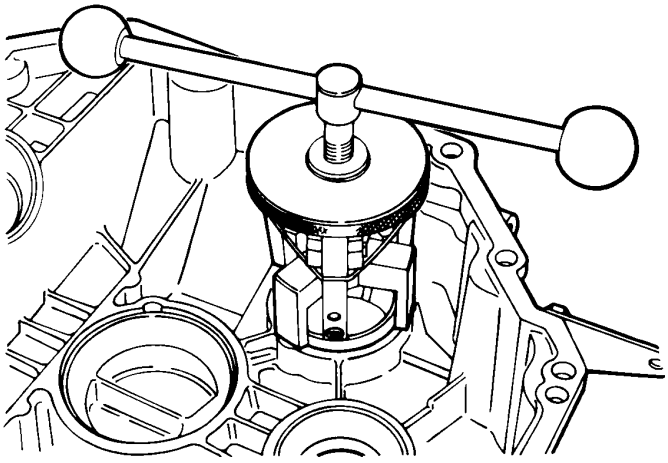
27681



72712

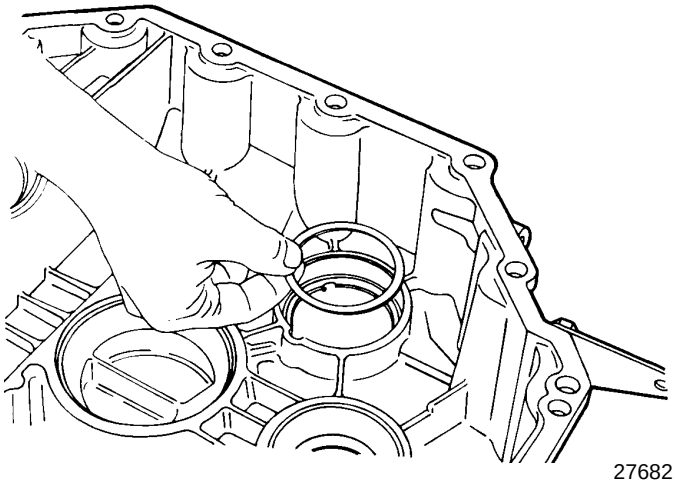
a - Small Diameter Puller Guide
b - Large Diameter Puller Guide

b. Pull bearing cup from housing using tool as shown.



27681

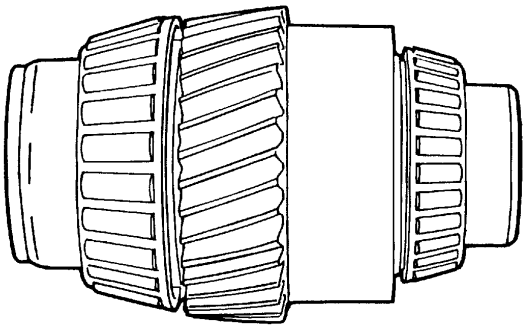
c. **Input Housing Side:** Remove and retain shims. DO NOT MIX UP.



27682

TAPERED ROLLER BEARINGS

IMPORTANT: Bearings and gear on output shaft are not replaceable. Replace output shaft, gear and bearings as a complete assembly only.



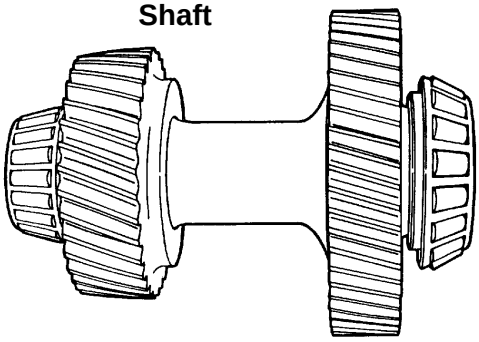
73028

⚠CAUTION

Gears should never be removed from intermediate shaft or output shaft, as this will affect proper gear alignment.

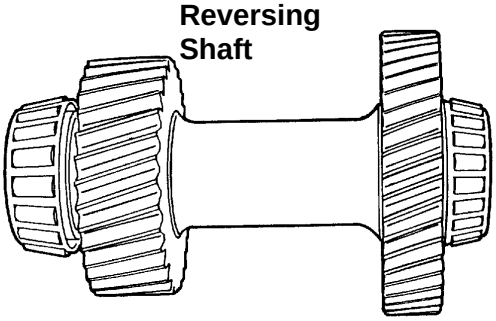
1. Remove tapered roller bearings from intermediate shaft and output shaft by using a universal puller plate and pressing bearings off.

Intermediate Shaft



73029

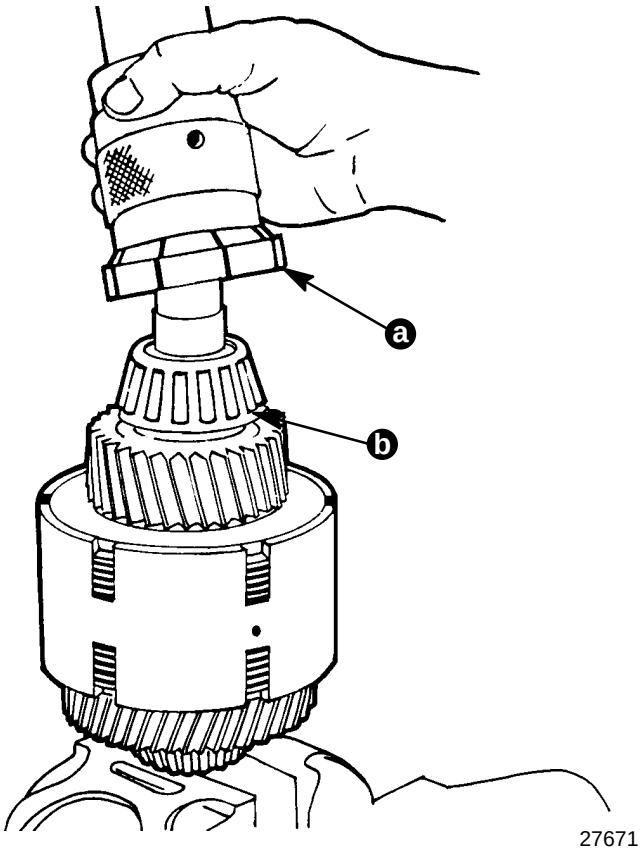
Reversing Shaft



73030

REVERSING CLUTCH, GEARS AND TAPERED ROLLER BEARINGS

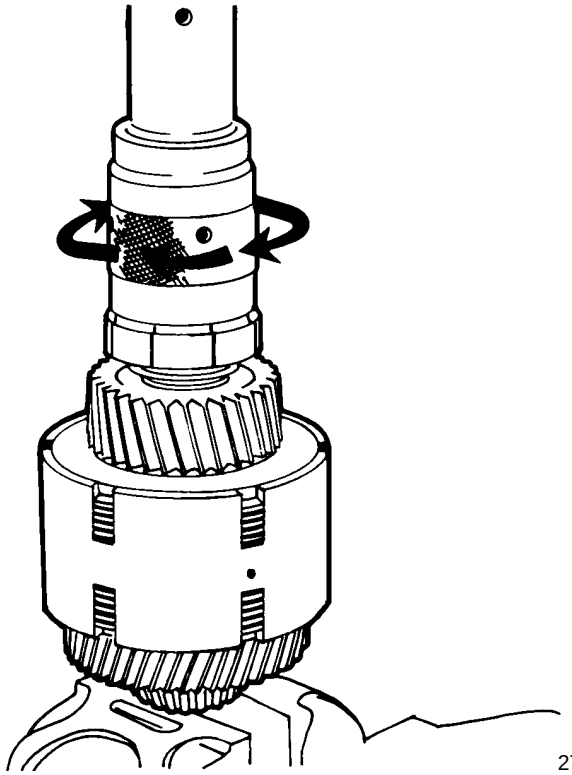
1. Remove tapered roller bearing from splined end of input shaft using special tool as follows:
   a. Place tool over tapered roller bearing. Ensure jaws of tool will be pulling on bottom edge of rollers and NOT on the cage.



27671

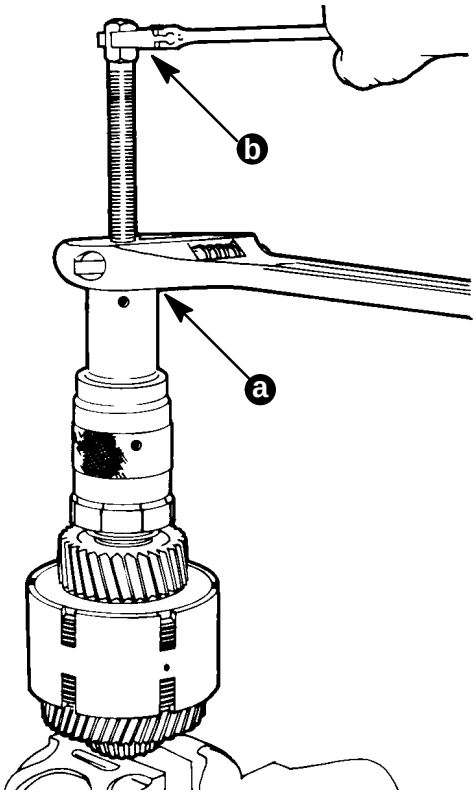
a - Jaws
b - Bottom Edge Of Rollers

   b. Tighten jaws onto bearing by turning on knurled part of tool. Tighten assembly.



27671

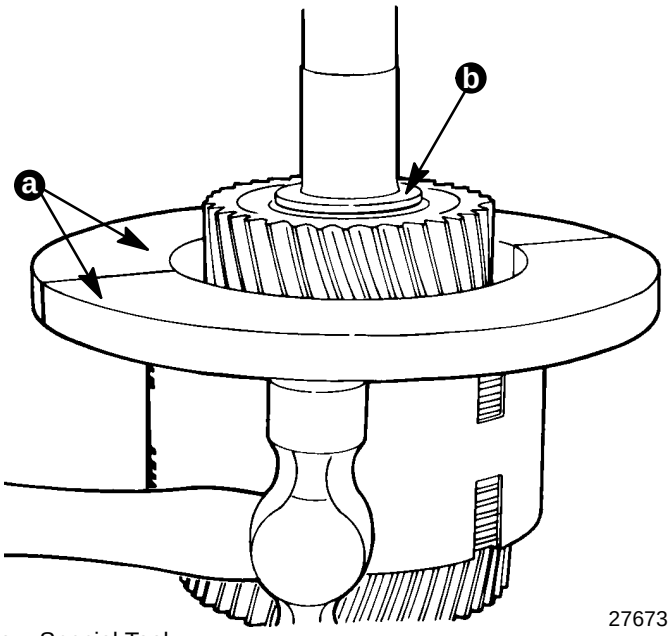
   c. Pull tapered roller bearing from shaft using tool as shown.



27672

a - Hold Tool Stationary
b - Turn Top Nut

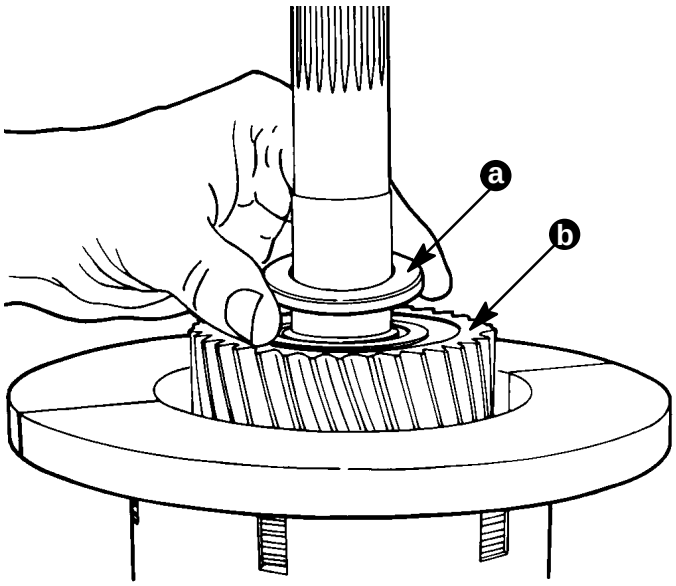
2. Remove butting ring from splined end of input shaft by installing special tool as shown and lightly tapping upward on tool.



27673

a - Special Tool
b - Butting Ring

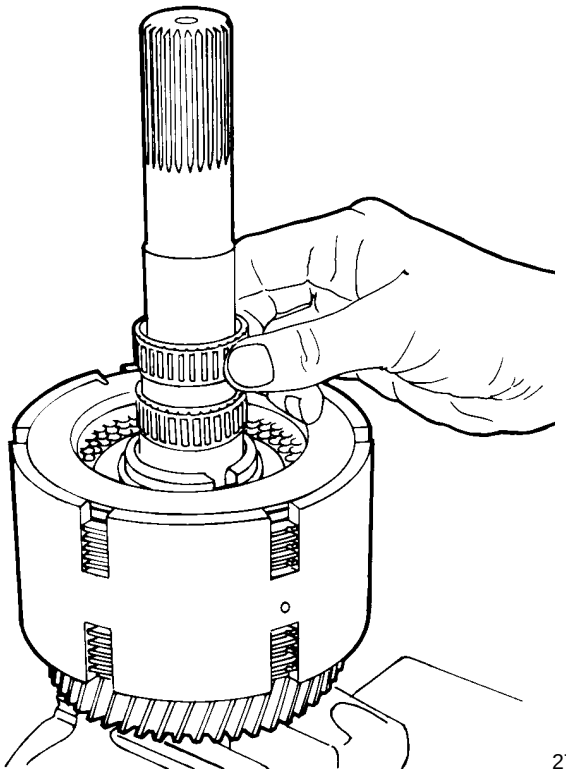
3. Remove butting ring and gear assembly.



27675

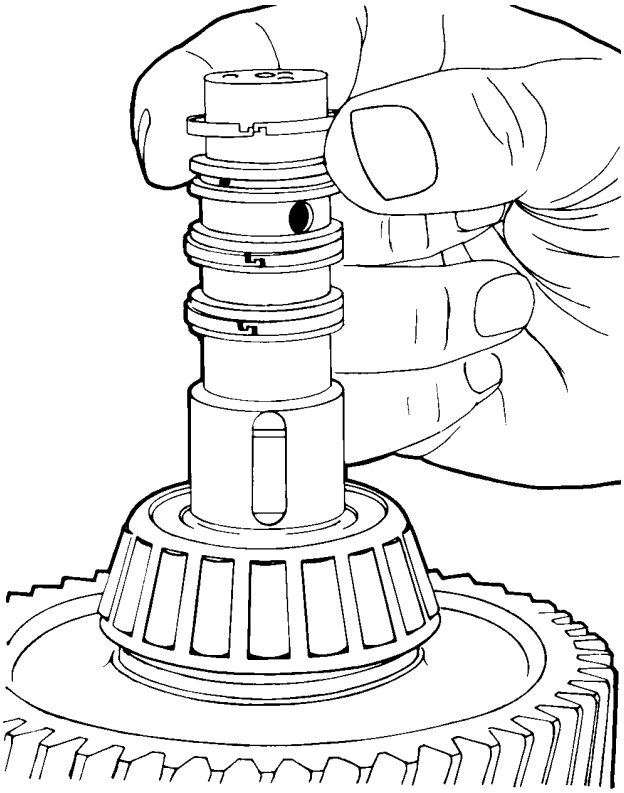
a - Butting Ring
b - Gear Assembly

4. Remove needle bearings.



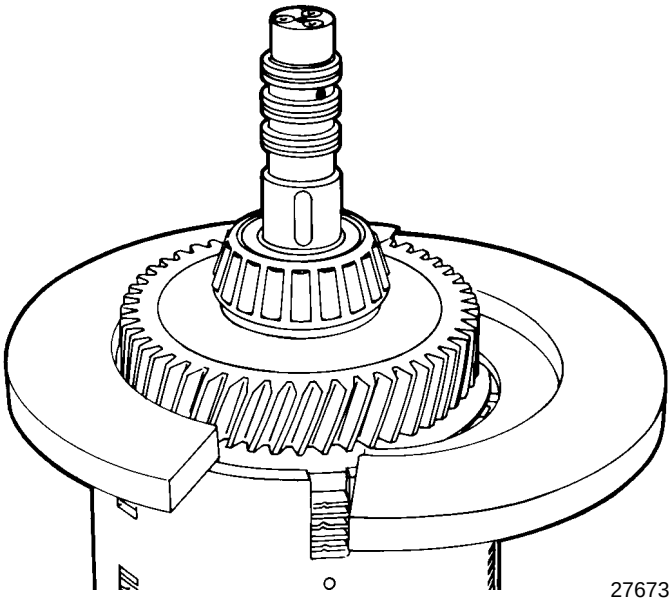
27680

5. Remove piston rings from shaft.



27679

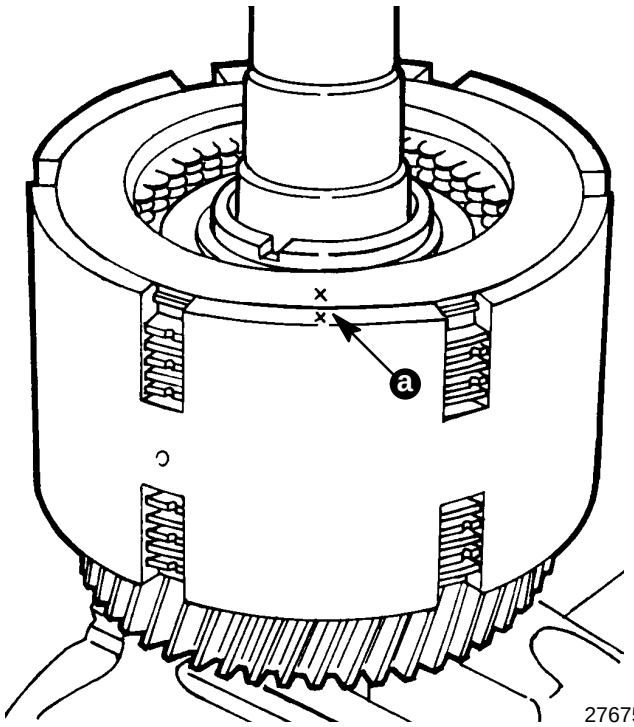
6. Remove tapered roller bearing, butting ring and gear from piston end of shaft using special tool as shown. Press all components off at the same time. Then, remove needle bearings.


27673

CLUTCH DISCS

NOTE: *Discs on both sides of clutch are removed in the same manner.*

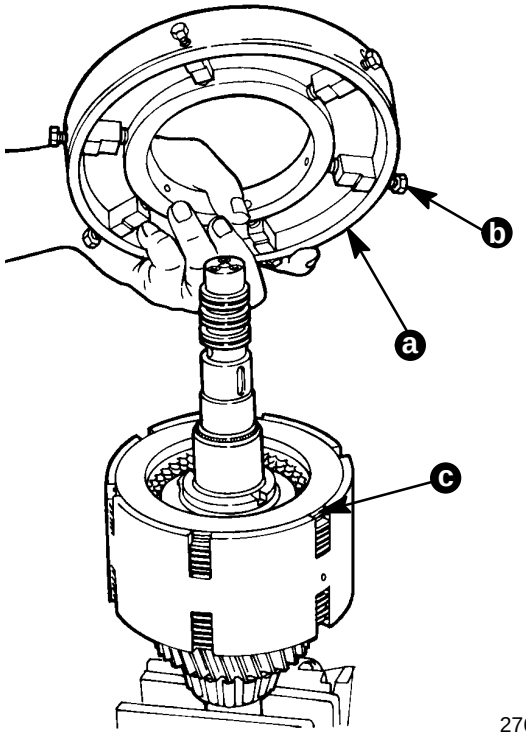
IMPORTANT: Reference marks are placed on the clutch housing and end disc to aid in locating the snap ring opening.



27675

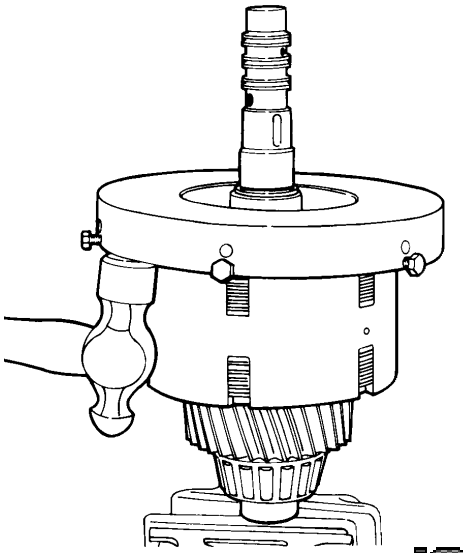
a - Reference Marks

1. Position snap ring compression tool on clutch assembly so that compression screws are centered over slots in clutch housing.
2. Remove end disc and snap ring as follows:
   a. Tighten all compression screws until a slight resistance is felt.
   b. Tighten compression screws evenly (approximately 1/2 turn at a time).
   c. Tap up lightly on bottom edge of compression tool until snap ring pops up and out of groove in clutch housing.

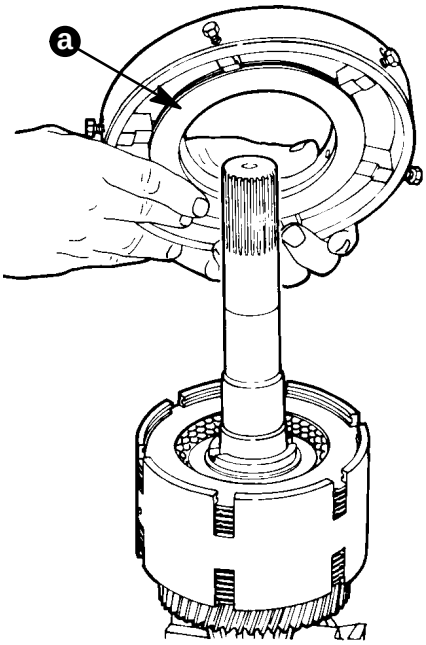


27674

a - Snap Ring Compression Tool
b - Compression Screws (6)
c - Slots


27675

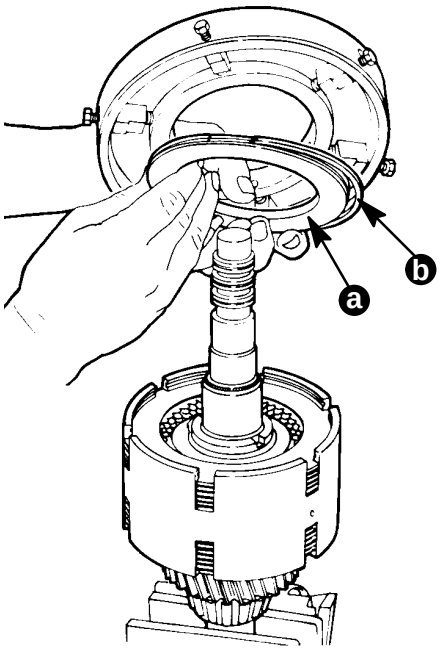
NOTE: *For ease of reassembly, end disc and snap ring should not be removed from tool unless their condition is questionable.*



27676

a - End Disc (Snap Ring Compressed)

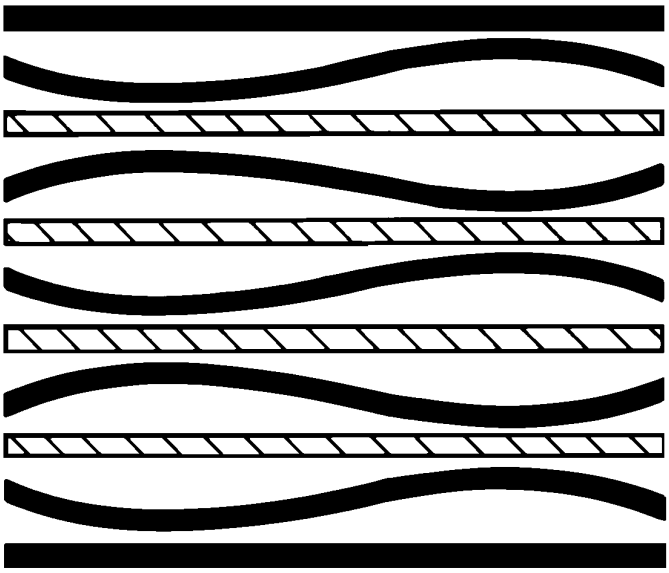
d. If necessary, remove end disc and snap ring from tool.



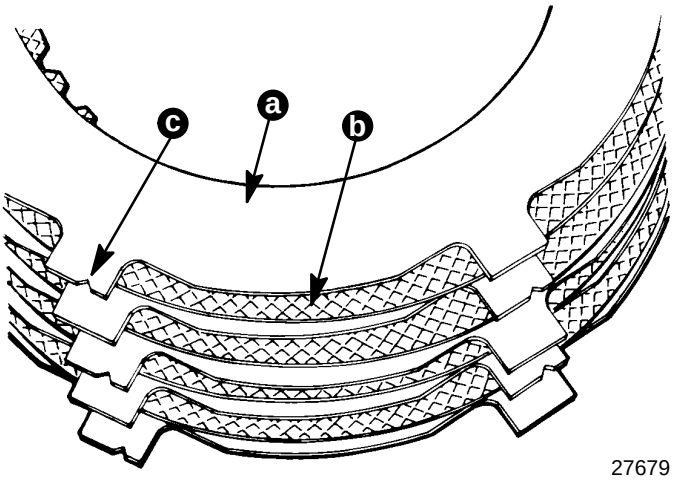
27676

a - End Disc
b - Snap Ring

IMPORTANT: Thrust discs have a wave pattern. These discs must be reinstalled in a specific pattern, when reassembled. Make note of notches in thrust disc tabs, and how they are arranged.



50248

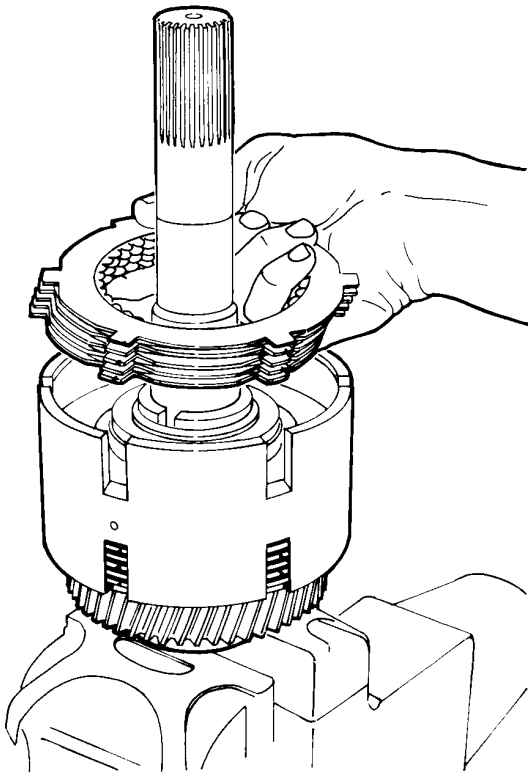


27679

630V Clutch Arrangement

a - Thrust Discs (5 Per Side) See Note
b - Inner Discs (4 Per Side) See Note
c - Notches

3. Remove discs.



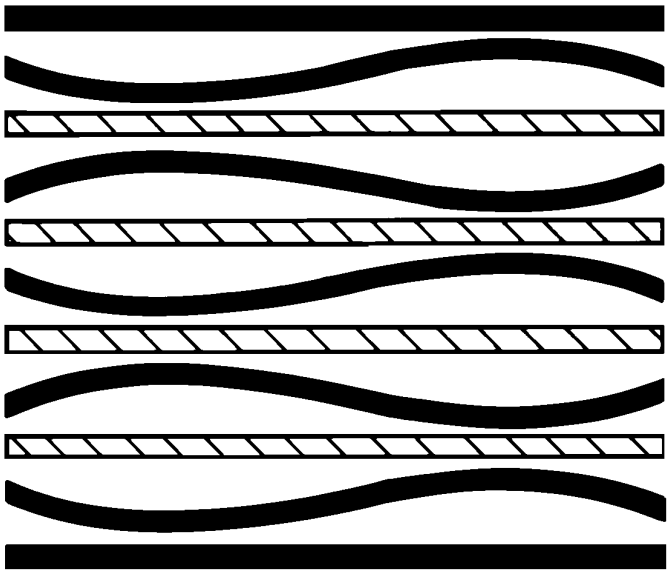
27680

4. Inspect thrust discs and inner discs for wear. Replace if there is any questionable wear.
5. Remove and inspect discs on opposite side of clutch in same manner.

Reassembly

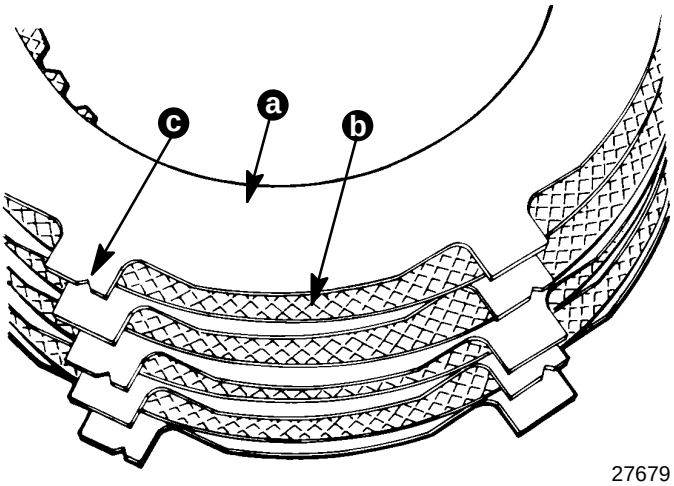
CLUTCH DISCS

IMPORTANT: Thrust discs have a wave pattern. These discs must be reinstalled in a specific manner as explained following.



50248

1. Arrange thrust discs and inner discs as shown. Ensure notches on thrust disc tabs are aligned as shown.

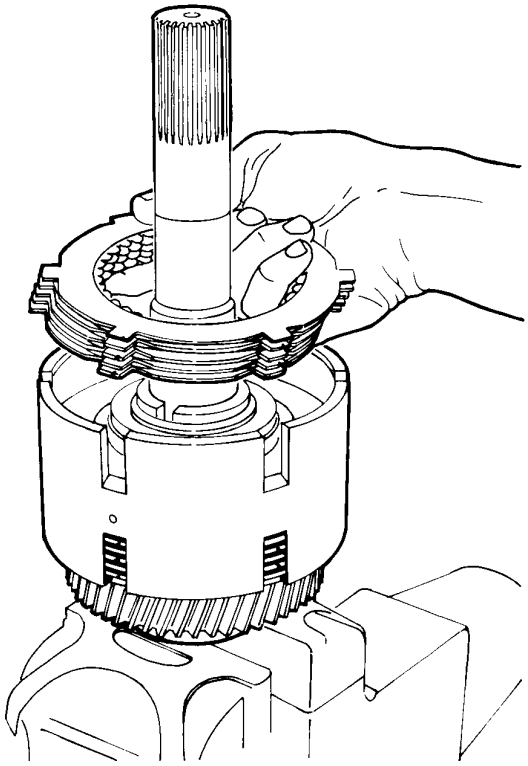


27679

630V Clutch Arrangement

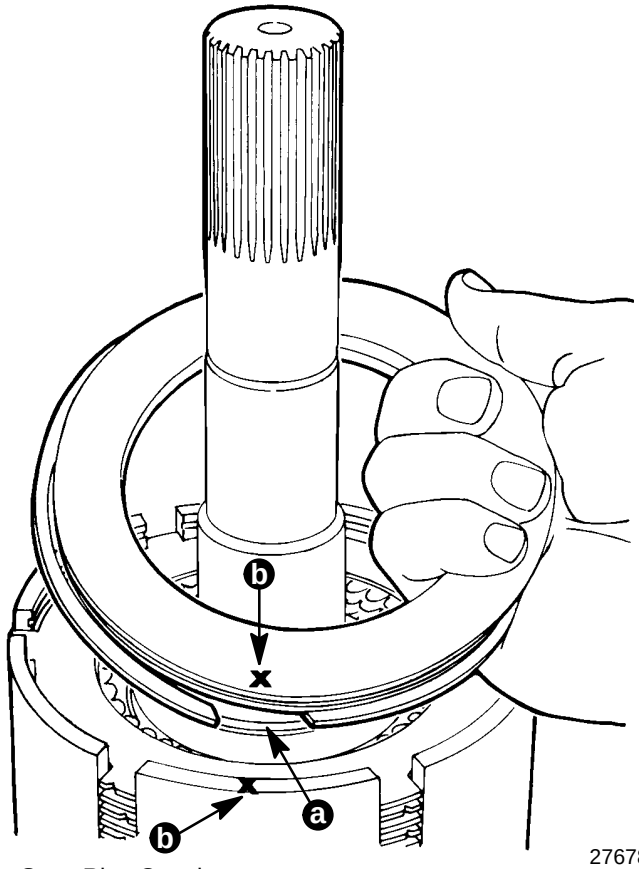
a - Thrust Discs (5 Per Side) See Note
b - Inner Discs (4 Per Side) See Note
c - Notches

2. Install discs in clutch housing.



27680

3. Align snap ring opening with reference marks on end disc and clutch housing.

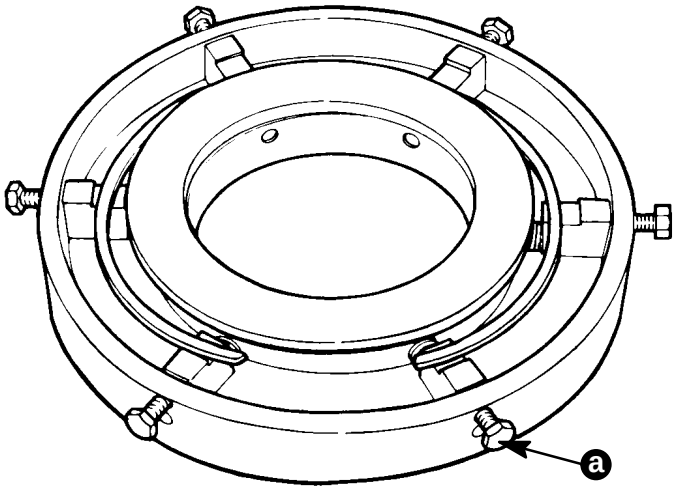


27678

a - Snap Ring Opening
b - Reference Marks

4. If end disc and snap ring were removed from tool, reinstall as follows:

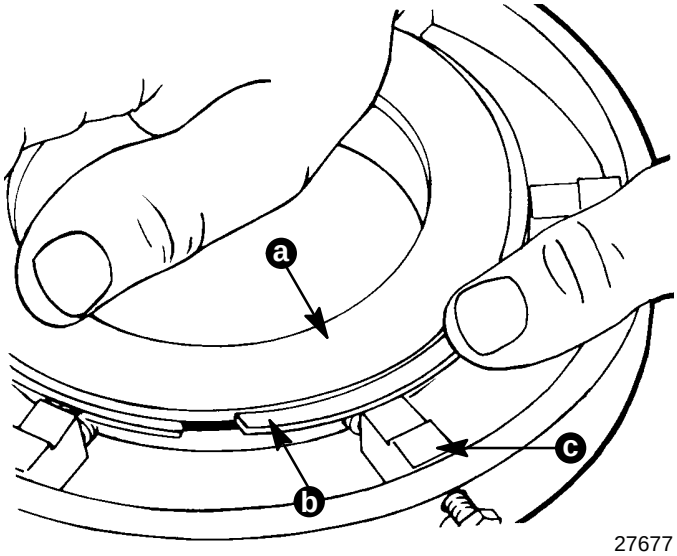
   a. Loosen all compression screws on tool.



27677

a - Compression Screws

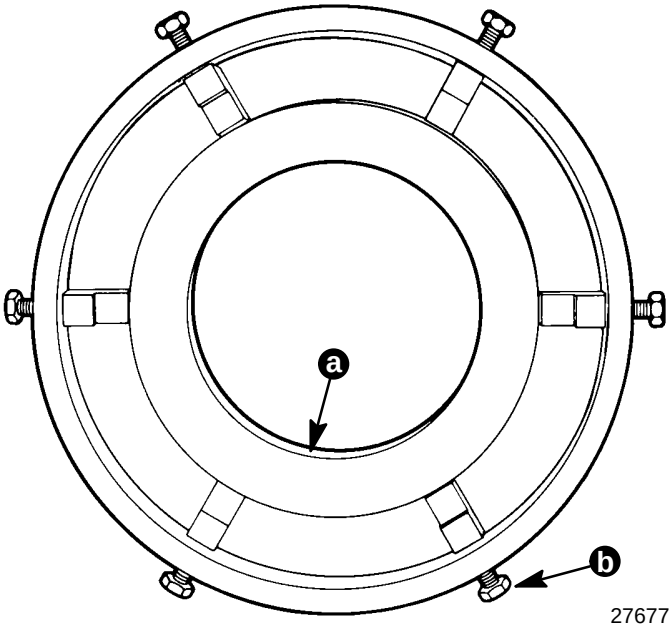
   b. Place snap ring into groove in end disc and compress by hand so that compression dogs will hold in on snap ring.



27677

a - End Disc
b - Snap Ring
c - Compression Dogs

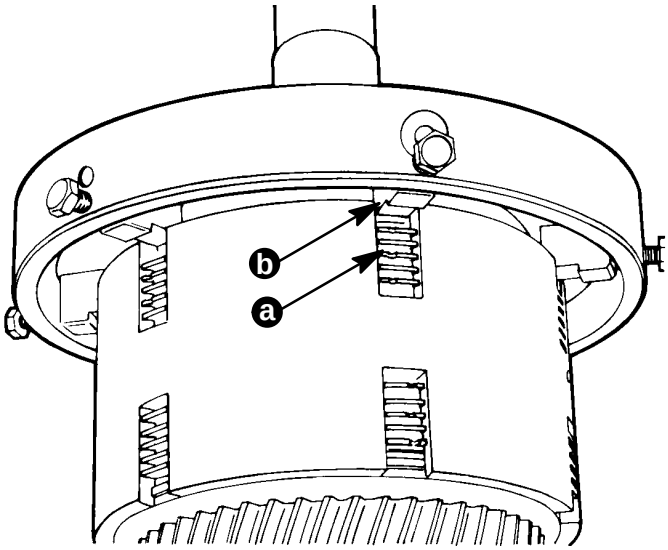
c. Tighten compression screws evenly to completely compress snap ring into end disc.



27677

a - End Disc
b - Compression Screws

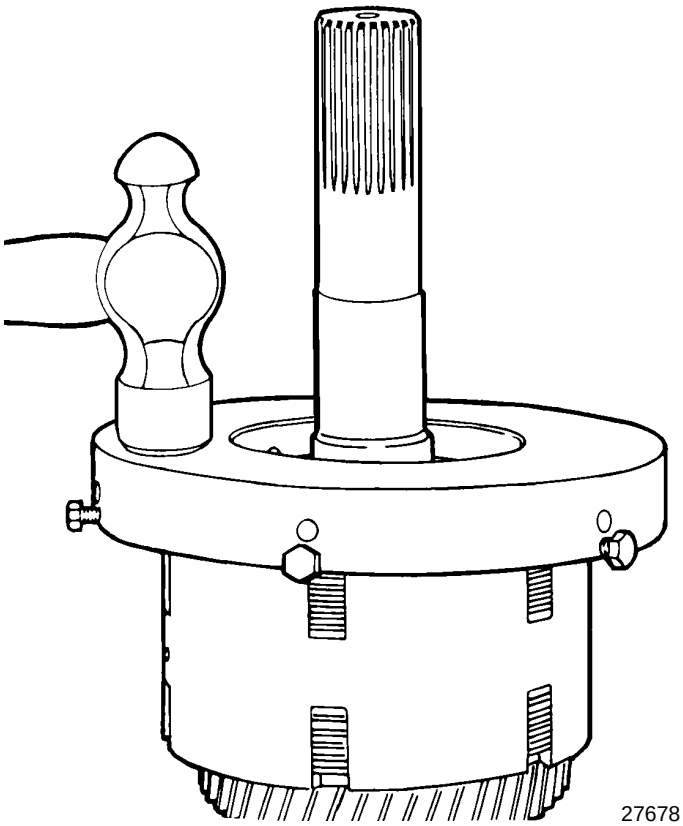
d. Carefully lower end disc and special tool onto clutch housing and align compression dogs with slots in housing.



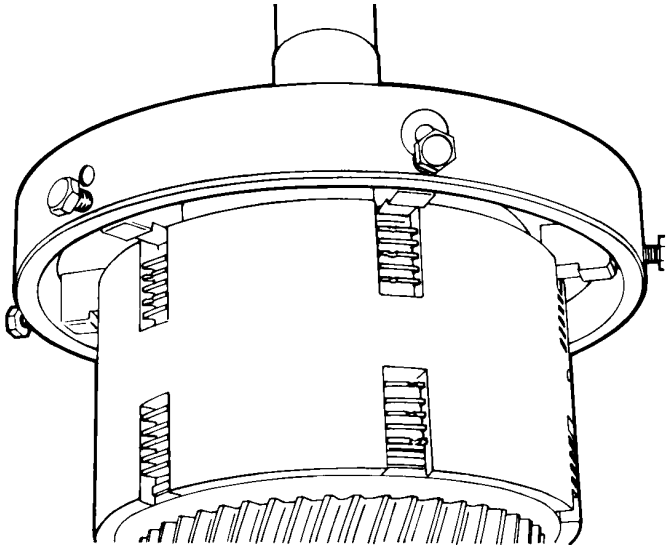
27675

a - Slots
b - Compression Dogs

5. Tap lightly around top of tool until end disc bottoms. Loosen compression screws and remove tool.

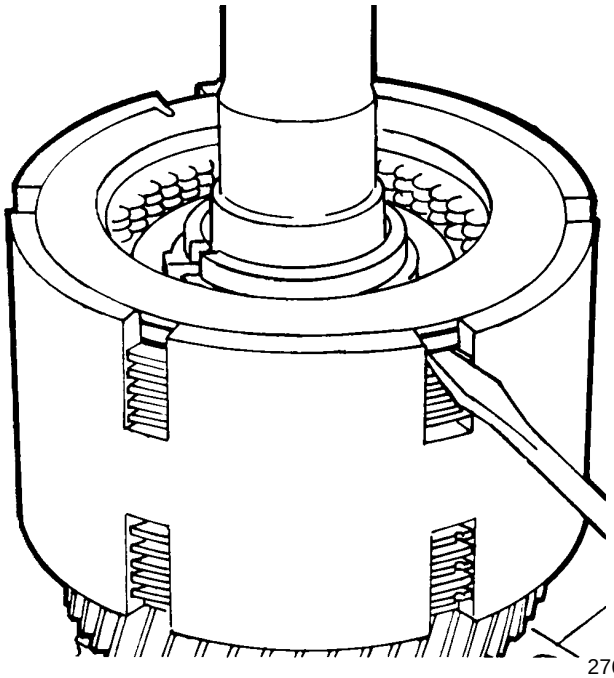


27678



27675

6. Double check that snap ring has been properly seated by prying up lightly on end disc.

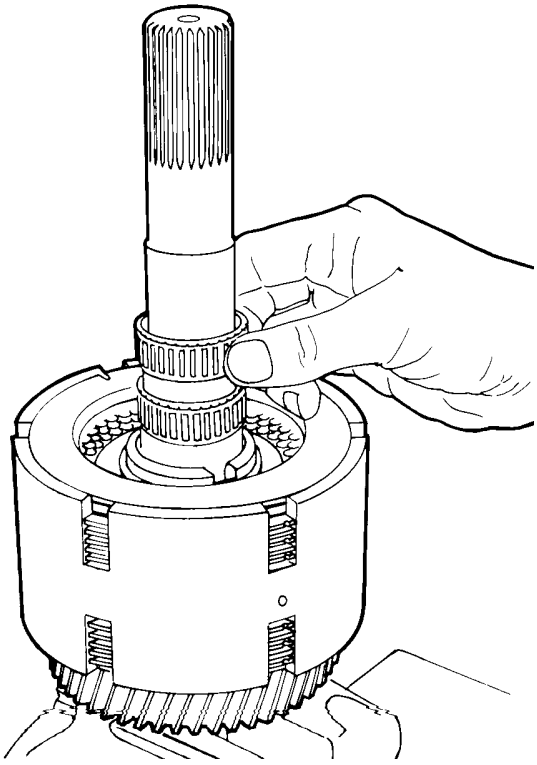


27679

7. Reinstall discs on opposite side of clutch in same manner.

NEEDLE BEARINGS

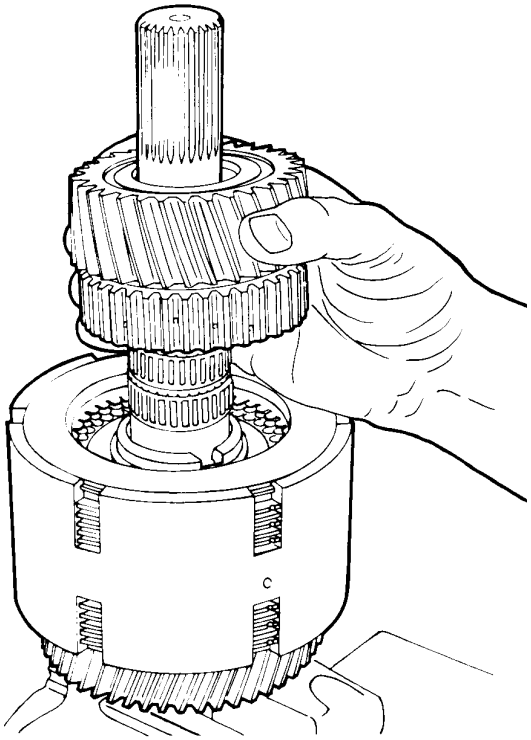
1. Reinstall needle bearings.



27680

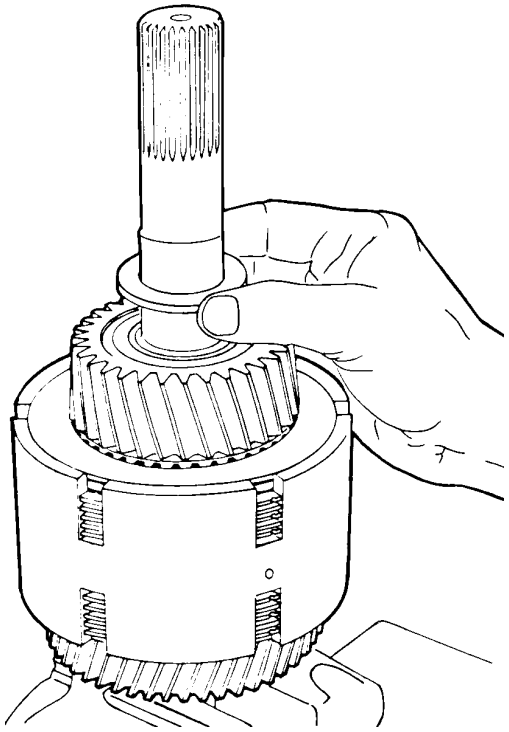
GEAR ASSEMBLY

1. Reinstall gear assembly. Twist gear assembly from side to side to allow splines to engage with inner discs. Ensure all inner discs are engaged with splines by observing through slots in clutch housing.



27673

2. Reinstall butting ring.



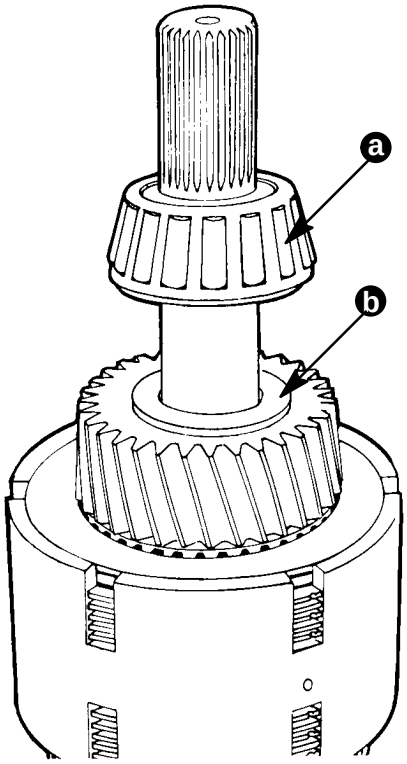
27672

TAPERED ROLLER BEARING

⚠CAUTION

Do not touch bearing once it has been heated. Severe burns could result. Use special protective gloves to handle bearing.

1. Heat inner race of tapered roller bearing using a torch lamp and press bearing onto shaft. When bearing has cooled down (DO NOT cool with water), tap bearing **carefully** down to ensure proper seating against butting ring, using a soft (copper) punch. **Tap on inner race only.**



27674

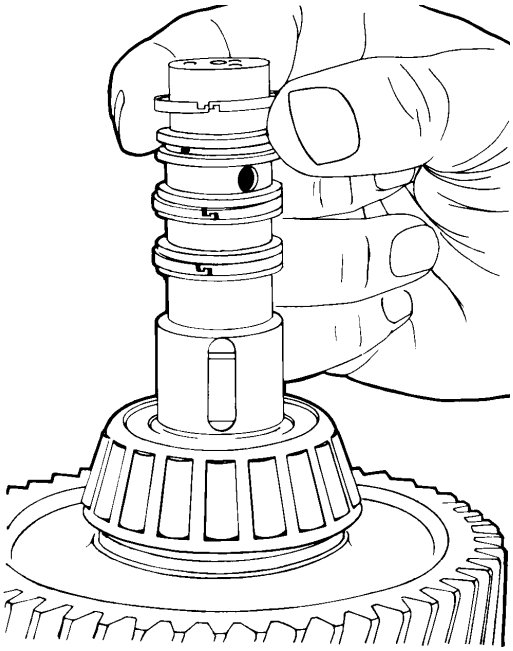
a - Tapered Roller Bearing
b - Butting Ring

2. Install components on opposite side of clutch assembly in same manner.

⚠CAUTION

Use care in reinstalling piston rings on input shaft. Piston rings are brittle and may snap if spread too far open.

3. Reinstall piston rings on input shaft. Ensure ends of rings are coupled as shown. Then position rings so that ends are staggered so no two are aligned.



27679

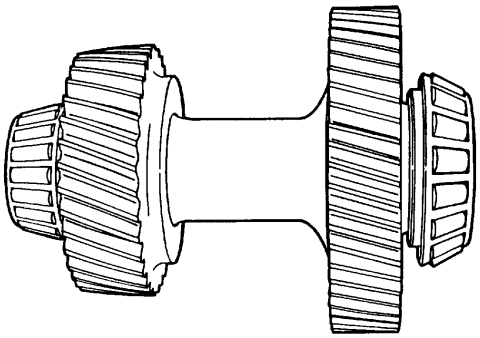
INTERMEDIATE SHAFT

⚠WARNING

Do not touch bearing once it has been heated. Severe burns could result. Use special protective gloves to handle bearing.

1. Heat inner race of tapered roller bearing using a torch lamp and press bearing onto shaft. When bearing has cooled down (DO NOT cool with water), tap bearing **carefully** down to ensure proper seating against gear, using a soft (copper) punch.

Tap on inner race only.



73029

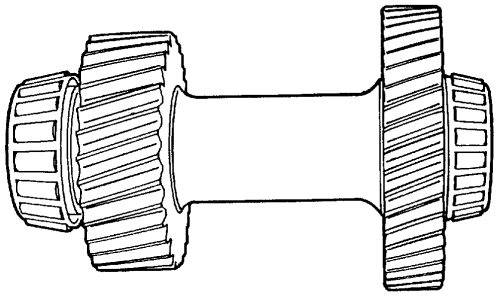
2. Install tapered roller bearing on opposite end of shaft in the same manner.

REVERSING SHAFT

⚠WARNING

Do not touch bearing once it has been heated. Severe burns could result. Use special protective gloves to handle bearing.

1. Heat inner race of tapered roller bearing using a torch lamp and press bearing onto shaft. When bearing has cooled (DO NOT cool with water), drive bearing down against gear using a soft (copper) punch. **Tap on inner race only**.



73030

2. Install tapered roller bearing on opposite end of shaft in the same manner.

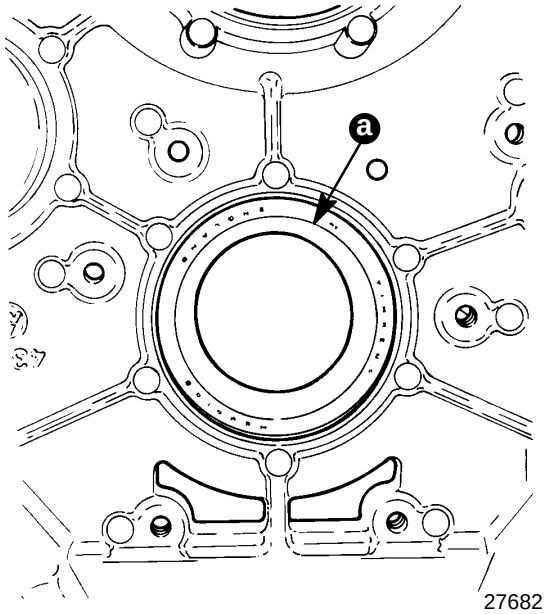
NOTE: *Bearing on splined end of shaft is tapped until seated against shoulder on shaft.*

PREASSEMBLY OF OUTPUT HALF OF HOUSING

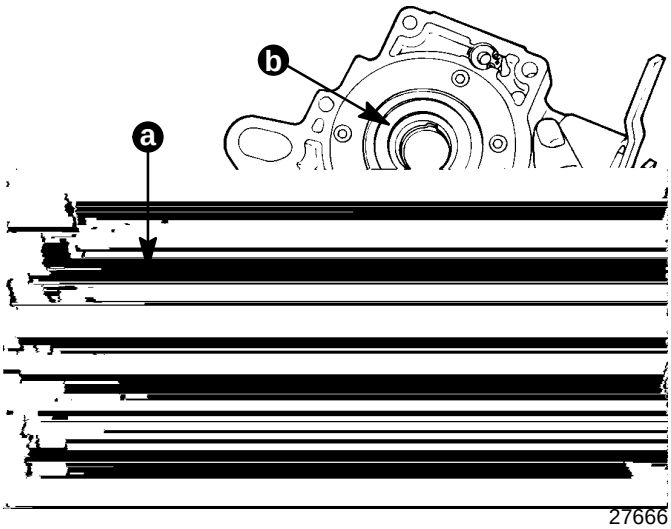
IMPORTANT: If tapered roller bearing cups were removed, ensure output shaft seal IS NOT in place, as it will be necessary to heat housing prior to installing bearing cups.

IMPORTANT: The tapered roller bearing cup on the input shaft (control block end) is properly positioned by bottoming out on the face of the control block assembly. It will be necessary to temporarily install control block to install this tapered roller bearing cup.

1. Temporarily install control block on outer housing. Tighten bolts securely.



27682



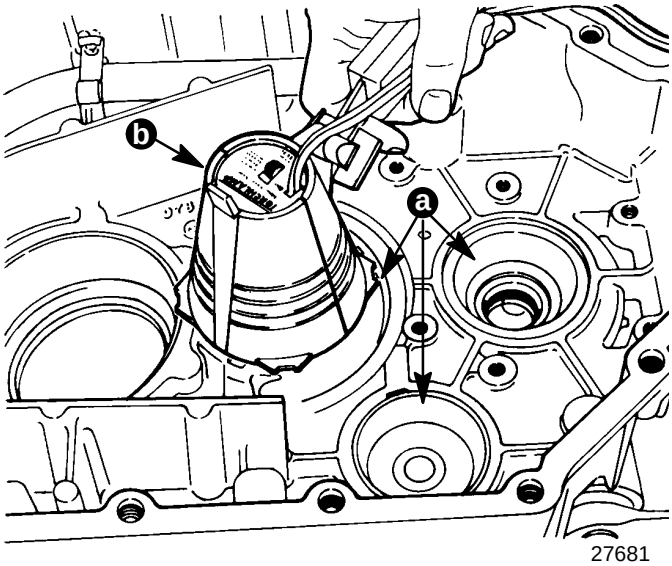
27666

a - Input Shaft Bearing Cup
b - Control Block Face

⚠WARNING

Use care in handling housing, once it is heated with torch lamp. Severe burns could result. Use special protective gloves when handling housing.

2. Heat bearing bores of housing using a torch lamp and install bearing cups using a suitable mandrel.



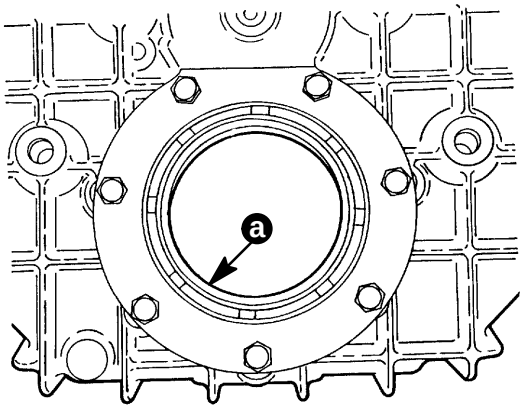
27681

a - Bearing Cups
b - Torch Lamp

3. Allow housing to cool (DO NOT cool with water) and then tap bearing cup with suitable mandrel to ensure it is properly seated.
4. Remove control block assembly.

Output Shaft Seal

1. **If bearing were not replaced and no shimming is required,** push new seal onto special mandrel. Ensure seal will be positioned with lip of seal facing inward. Drive seal uniformly into bore of housing to the point that it is countersunk .040 in. (1 mm) with reference to housing surface.

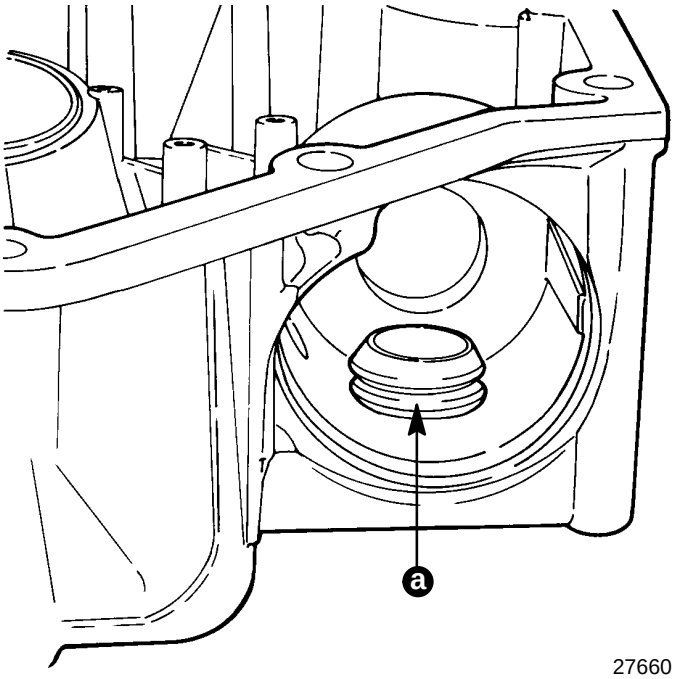


73027

a - Seal

Suction Pipe

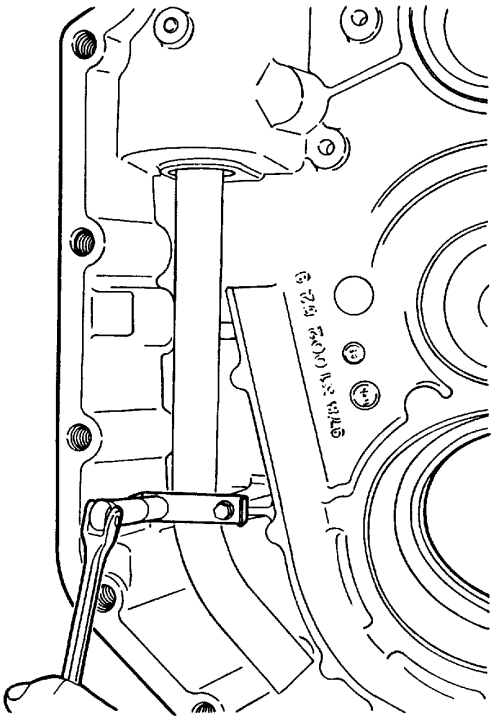
1. Reinstall suction pipe seal in bottom of oil filter bore. Coat seal with ATF.



27660

a - Seal

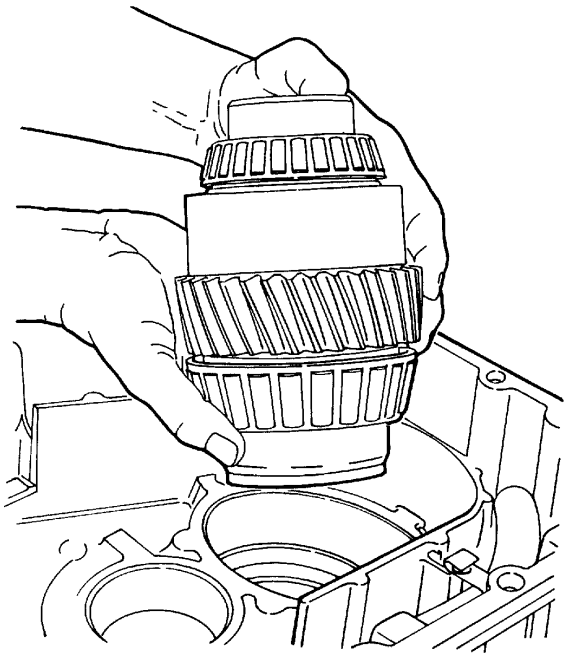
2. Reinstall suction pipe. Place one drop of Loctite Type A on screw threads. Then secure suction pipe down with retainer plate. Tighten screws securely.
3. Bend tabs down over screws.



73025

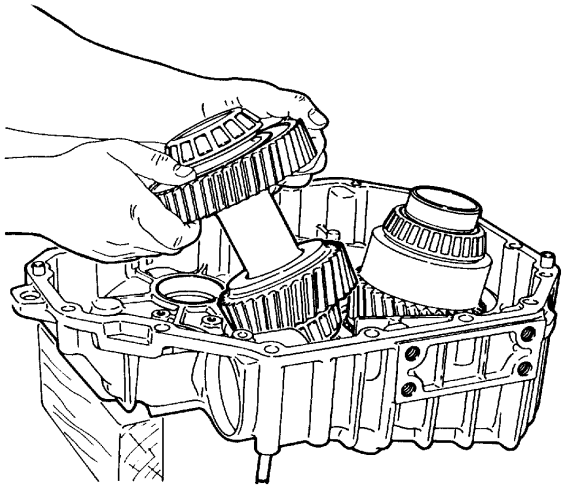
Shafts

1. Coat tapered roller bearings with ATF.
2. Install output shaft.



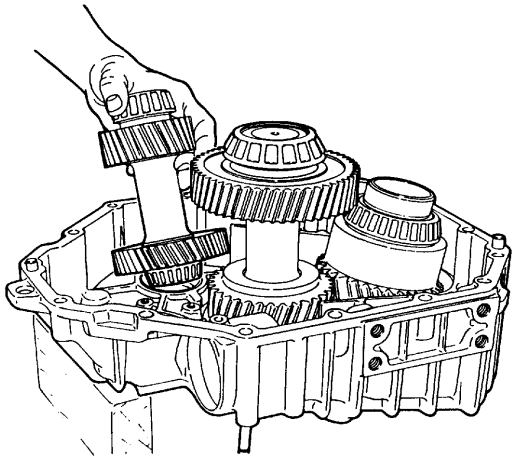
73023

3. Install reversing shaft.



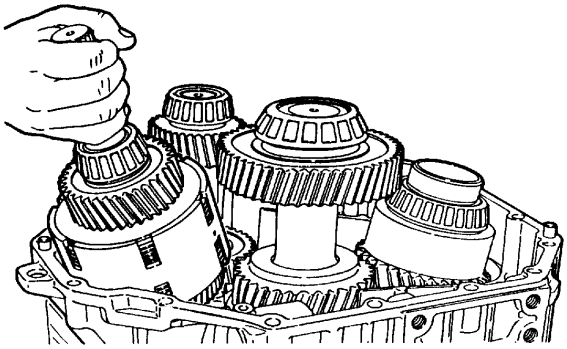
73022

4. Install intermediate shaft.

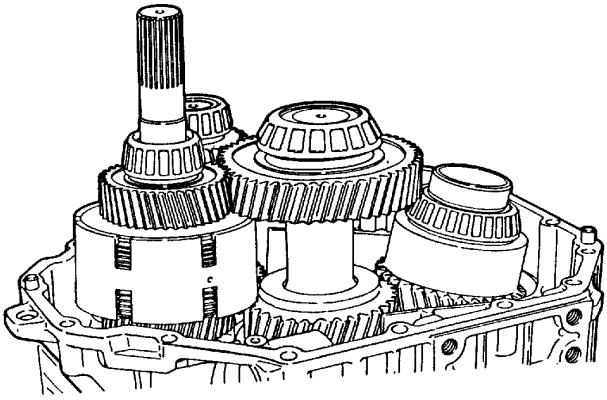


73021

5. Install input shaft. Ensure all gears mesh as shown.



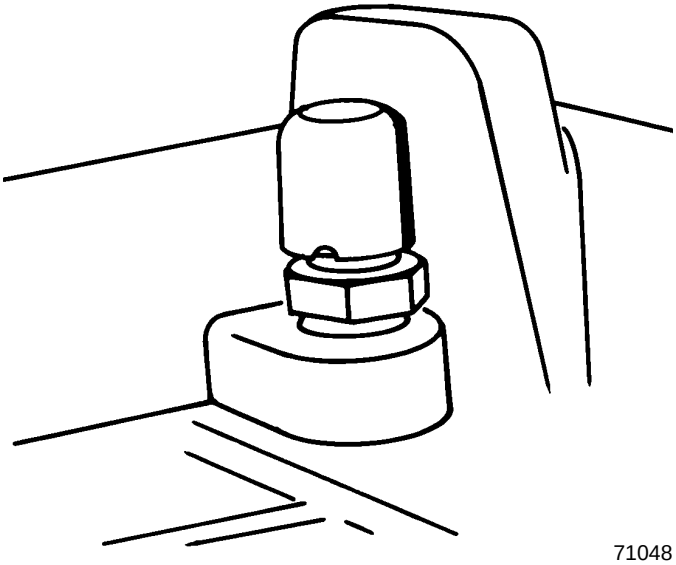
73020



73031

PREASSEMBLY OF INPUT HALF OF HOUSING

1. Install breather valve (do not over-tighten).



71048

Bearing Preload Adjustment

IMPORTANT: If new tapered roller bearings have been installed, the preload must be readjusted. If bearings were not replaced, proceed to the "Final Assembly."

NOTE: *The required preload of bearings of the individual shafts is obtained by using shims beneath the tapered roller bearing cups in the input half of the housing.*

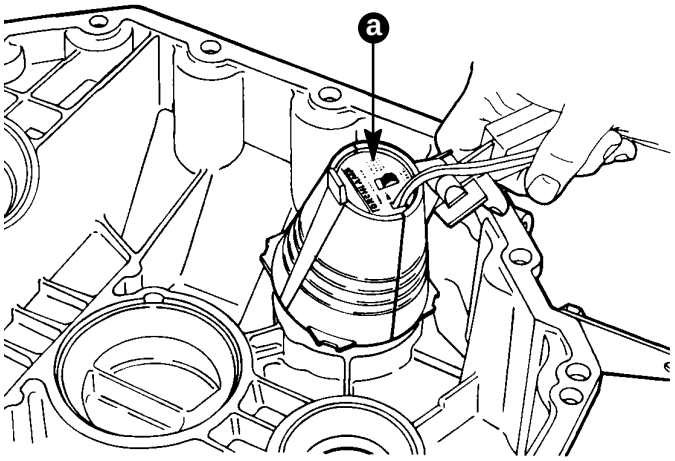
NOTE: *Shims which have been removed during disassembly may be reused.*

1. Subtract approximately .008 in. (.2 mm) of shims from each bearing cup bore. Remove and set aside, but do not mix up.

⚠ WARNING

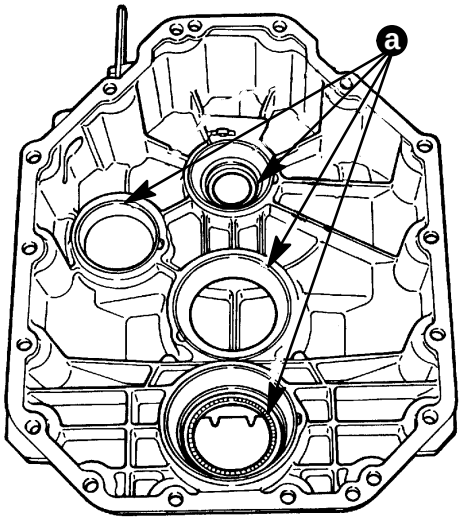
Use care in handling housing once it has been heated with a torch lamp. Severe burns could result. Use special protective gloves when handling housing.

2. Heat each tapered roller bearing cup bore with a torch lamp. Insert shims (less those removed) and bearing cups into appropriate bearing bores. When housing has cooled (DO NOT cool with water), tap bearing cups with a suitable mandrel to ensure that cups are fully seated.



27681

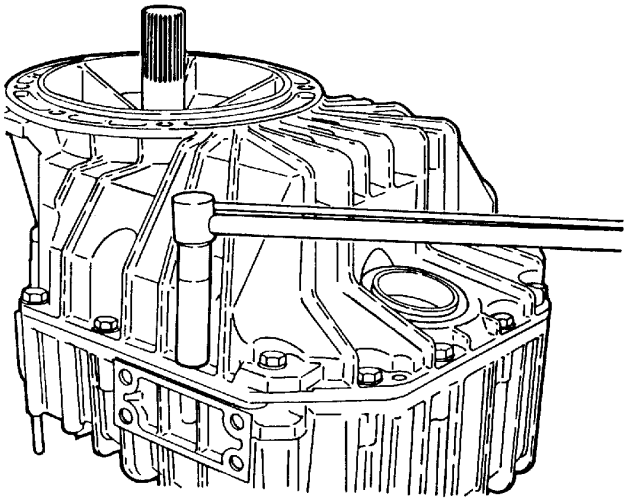
a - Torch Lamp



73032

a - Bearing Cups

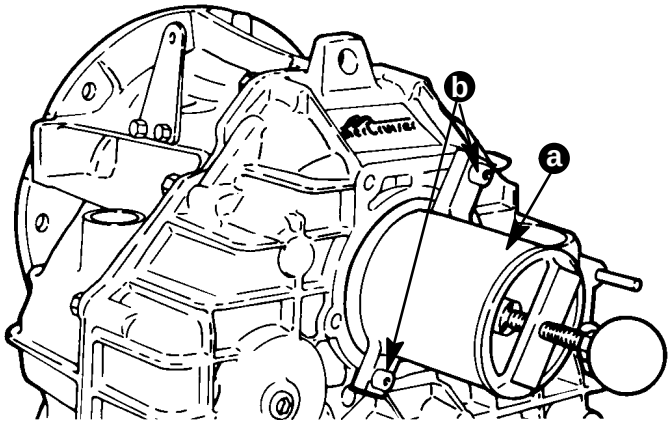
3. Install input half of housing onto output half. Ensure locator pins are in place. Install bolts and lockwashers and torque to 36 lb. ft. (49 N•m).



73033

Input Shaft Preload

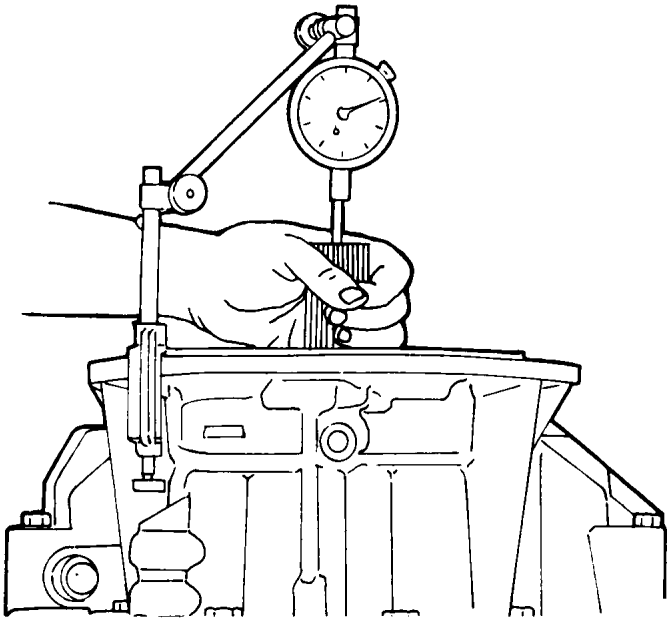
1. Measure bearing clearance as follows:
   a. Install special tool as shown. Tighten hold down bolts securely.



27863

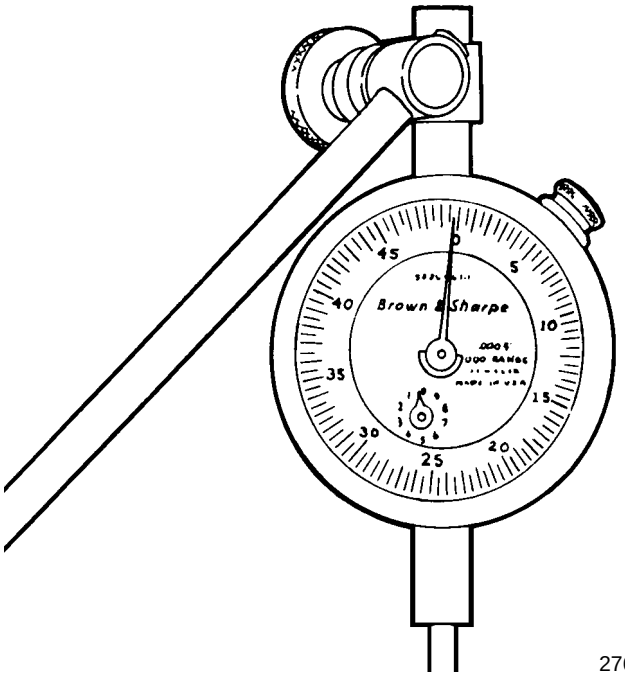
a - Special Tool
b - Hold Down Bolts

   b. Mount dial indicator on input shaft. Turn input shaft several times to seat bearing.



27685

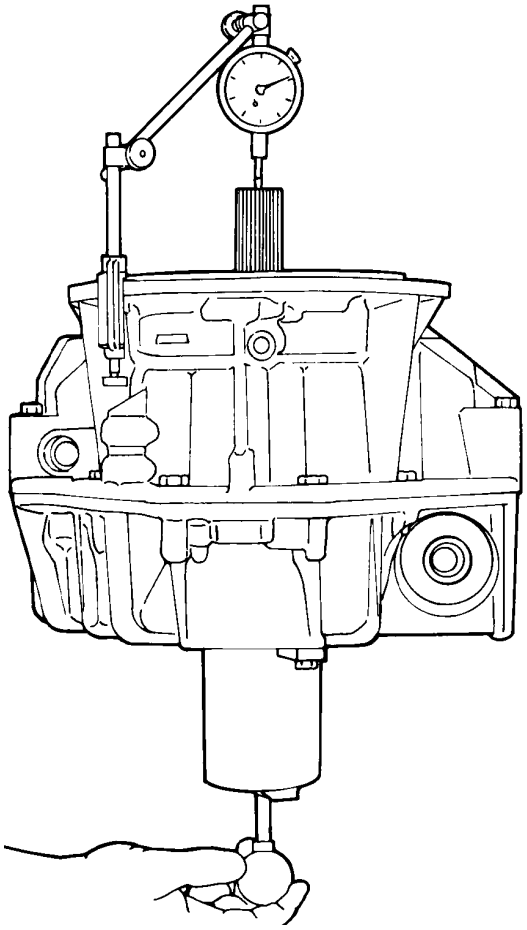
   c. Zero the dial indicator.



27685

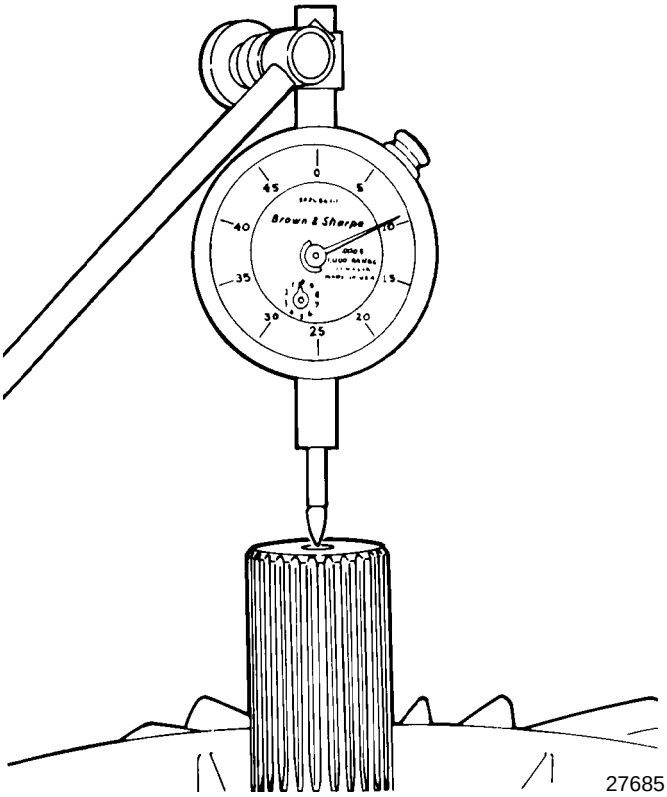
IMPORTANT: The following step should be done very carefully to obtain the actual bearing clearance. Avoid bumping the input shaft and turn very slowly on the special tool knob. (Shaft will only be moving a very small amount.)

d. Slowly turn the special tool knob clockwise to push the shaft upward. (Perform the above sequence several times to ensure on accurate reading.)



27682

e. Make note of reading. The bearing clearance measured **PLUS** the preload required is equal to the amount of shim thickness to be **ADDED.**



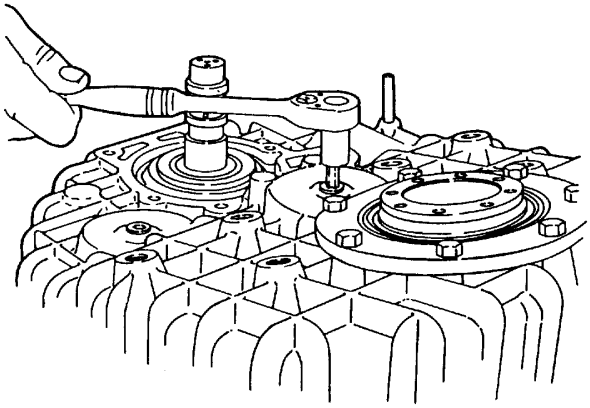
27685

Example:

	Bearing Clearances Measured	.009 in.
+	Bearing Preload Required	.004 in.
=	Shims to Be Added	.013 in.

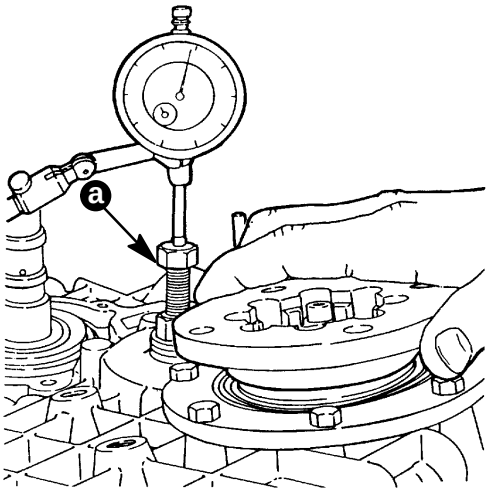
Intermediate Shaft Preload

1. Measure bearing clearance as follows:
   a. Remove hex plug from housing.



73034

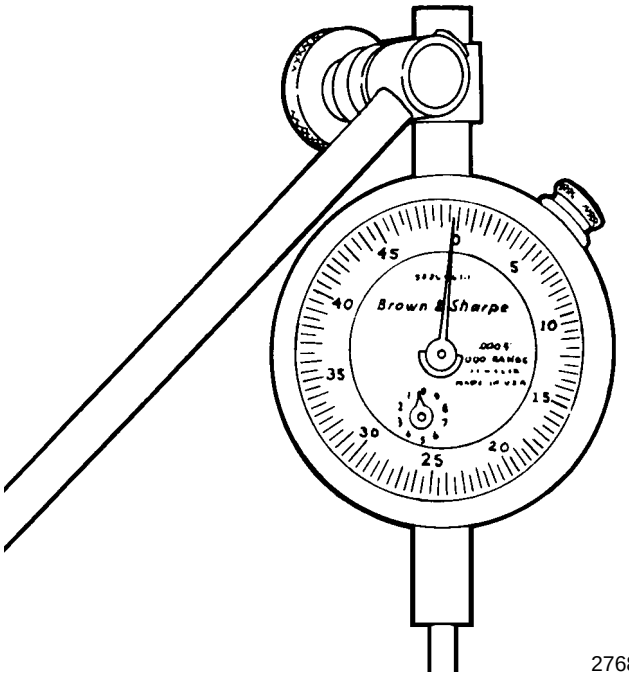
   b. Screw special bolt with nut into intermediate shaft and tighten snugly. Turn nut up until it touches bolt head.
   c. Mount dial indicator on bolt head. Turn output shaft several times to ensure bearing is seated.



73035

a - Special Bolt With Nut

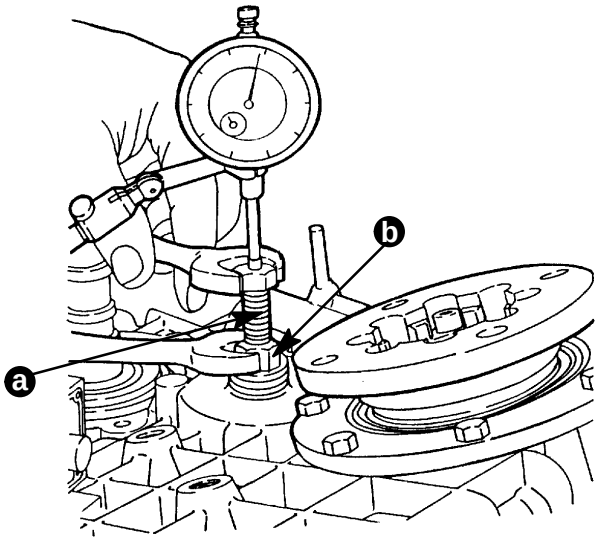
   d. Zero dial indicator.



27685

IMPORTANT: The following step should be done very carefully, to obtain the actual bearing clearance. Turn nut very slowly as shaft will only be moving a small amount.

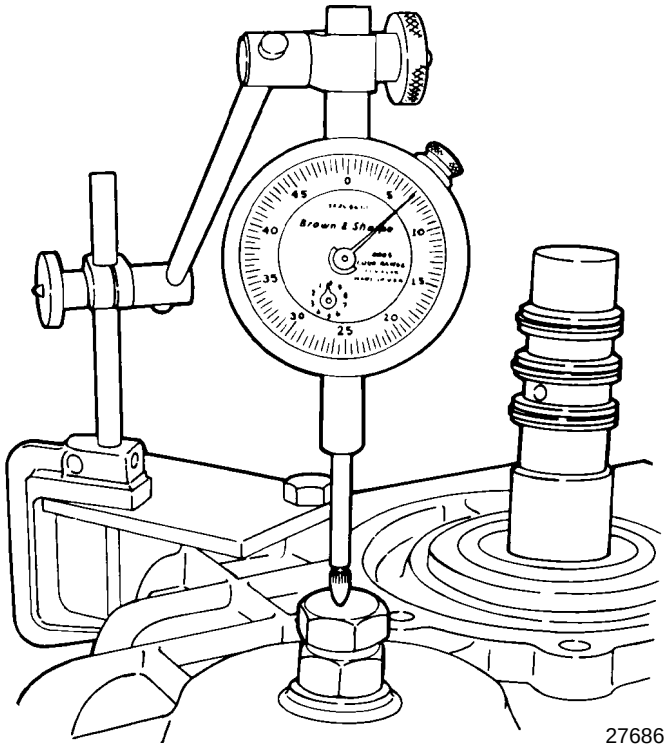
   e. Hold bolt with one wrench and slowly turn down nut to pull shaft upward. (Perform the above sequence several times to ensure accurate reading.)



73036

a - Bolt - Hold Stationary
b - Nut - Turn To Move Shaft

f. Make note of the reading. The bearing clearance measured **PLUS** the preload required is equal to the amount of shim thickness to be **ADDED.**



27686

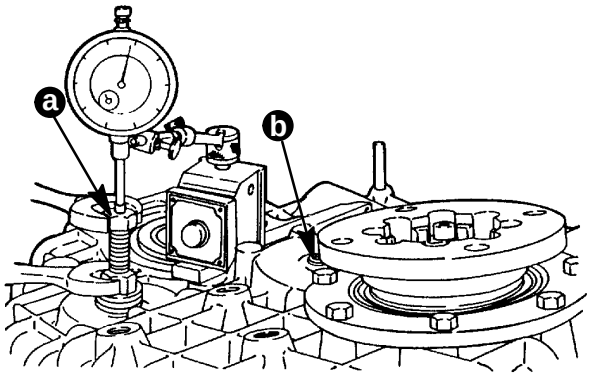
Example:

	Bearing Clearance Measured	.007 in.
+	Bearing Preload Required	.004 in.
=	Shims to Be Added	.011 in.

g. Remove dial indicator, special bolt and nut, and reinstall hex plug. Tighten securely.

Reversing Shaft Preload

The reversing shaft preload is adjusted exactly the same as the intermediate shaft. Refer to that procedure for adjusting reversing shaft.

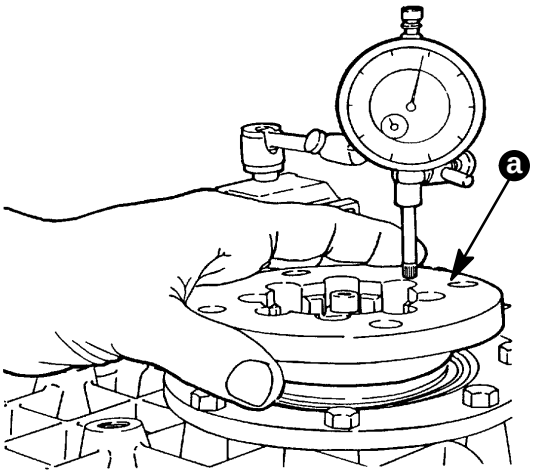


73037

a - Reversing Shaft Location
b - Intermediate Shaft Location

Output Shaft Preload

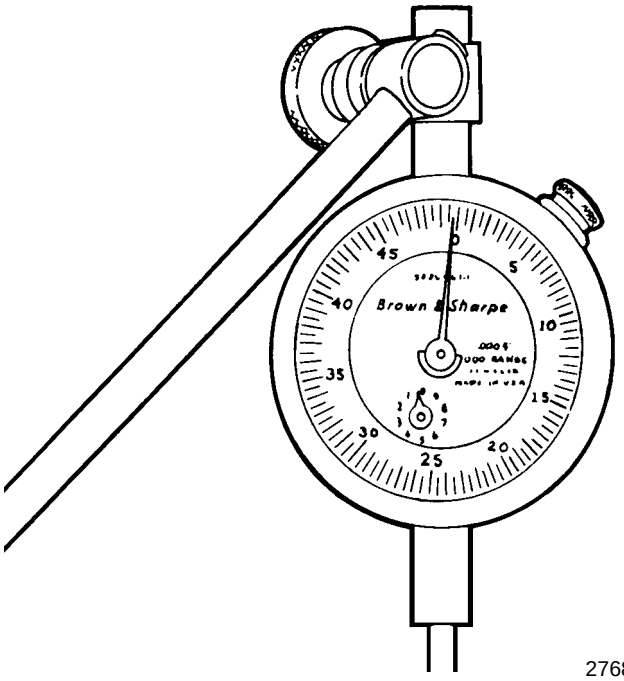
1. Measure the bearing clearance as follows:
   a. Install flange with bolts and washers. Tighten snugly.
   b. Mount dial indicator on flange. Turn output shaft several times to ensure bearing is seated.



73038

a - Flange

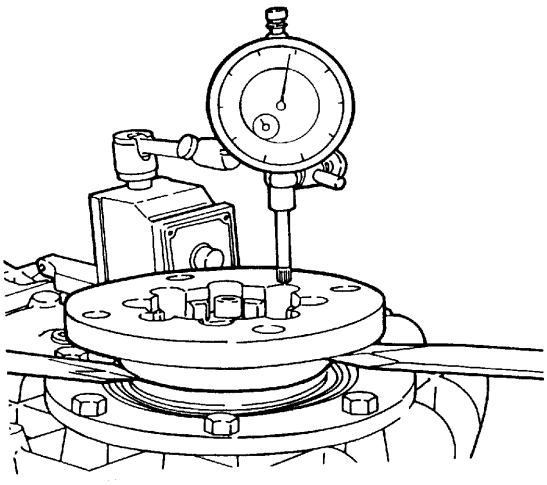
c. Zero dial indicator.



27685

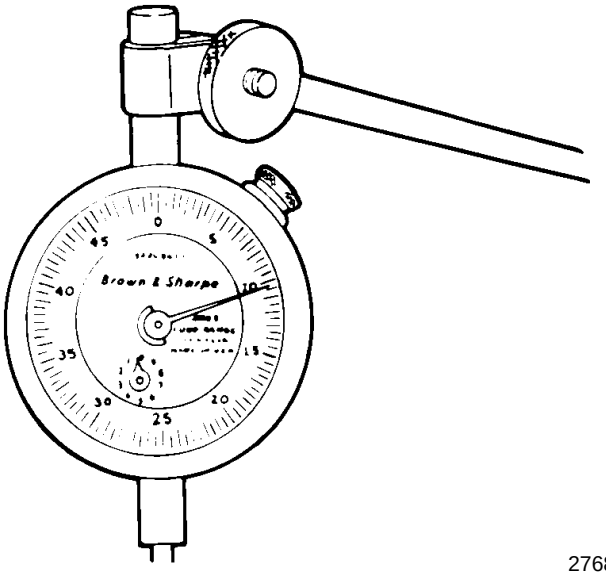
IMPORTANT: The following step should be done very carefully to obtain the actual bearing clearance. Pry up gently and evenly to lift shaft. Shaft will only move a small amount.

d. Pry up on flange to lift output shaft.



73039

e. Make note of the reading. The bearing clearance measured **PLUS** the preload required is equal to the amount of shim thickness to be **ADDED.**

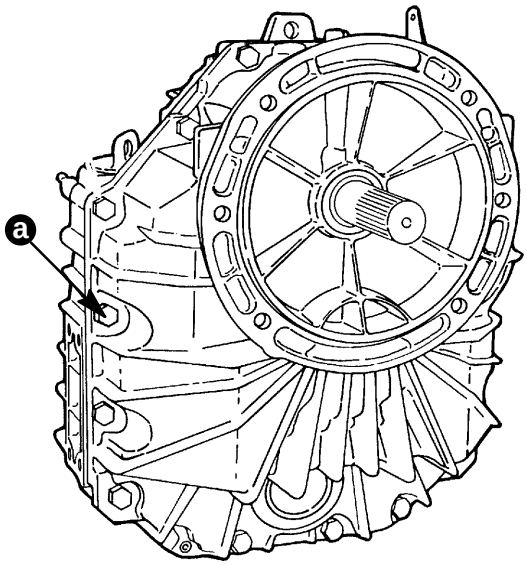


27686

Example:

	Bearing Clearance Measured	.010 in.
+	Bearing Preload Required	.004 in.
=	Shims to Be Added	.014 in.

2. When thickness of shims to be **ADDED** has been determined, the input half of housing must again be removed. Remove bolts and lockwashers, then lift off input half of housing.

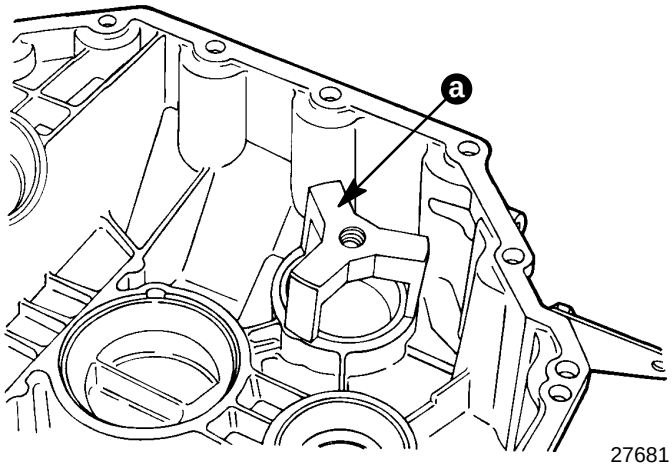


73018

a - Hex Bolts (16)

3. Remove tapered roller bearing cups from housing using special puller as follows:

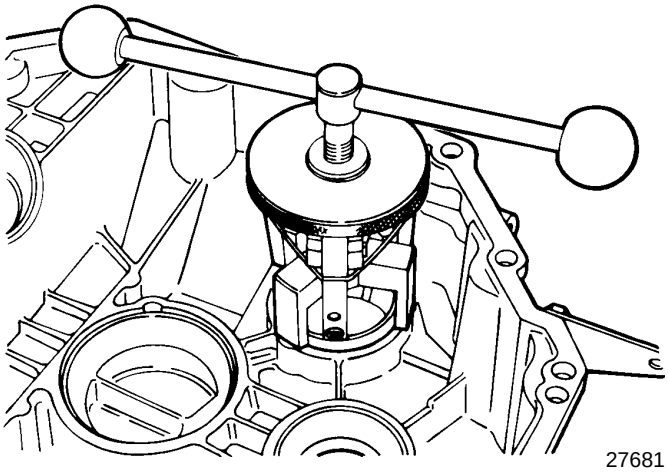
   a. Position appropriate puller guide (large or small diameter) over cup as shown.



27681

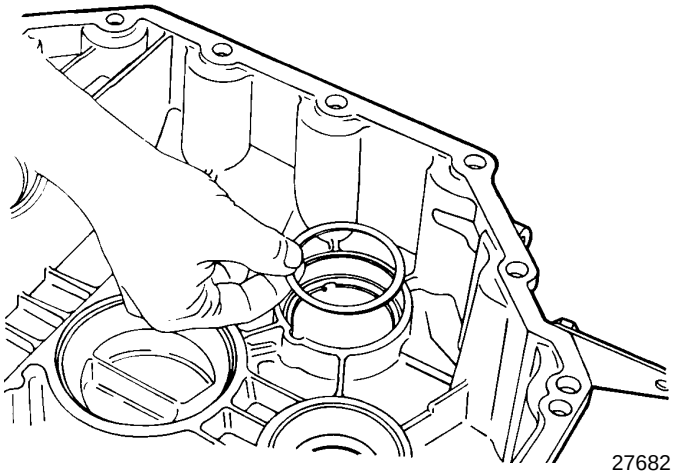
a - Small Diameter Puller Guide

   b. Pull bearing cup from housing as shown.



27681

4. Add the necessary amount of shims as determined previously to the appropriate bearing bores.

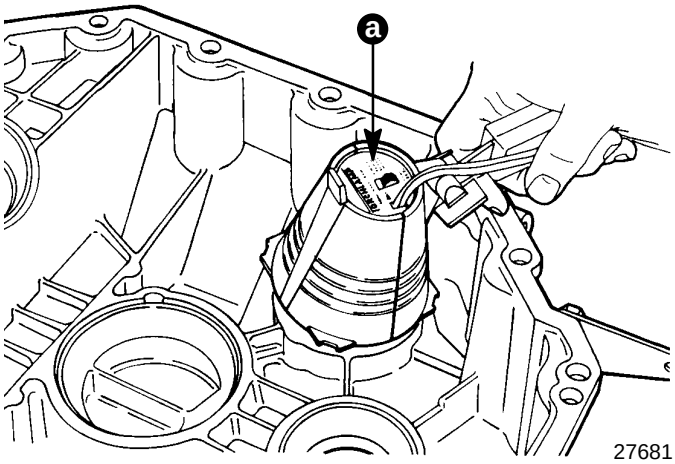


27682

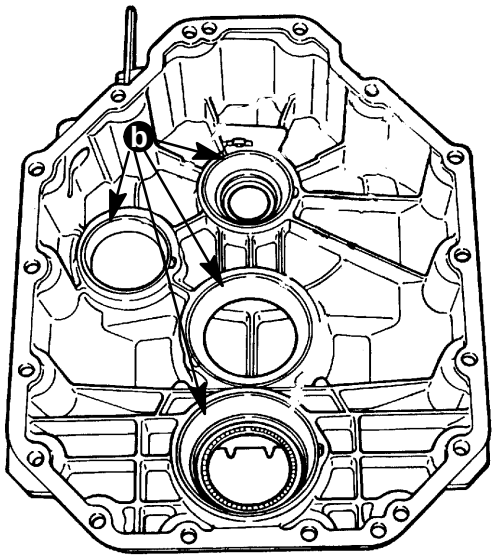
⚠WARNING

Use care in handling housing once it has been heated. Severe burns could result. Use special protective gloves to handle housing.

5. Heat each tapered roller bearing cup bore with a torch lamp. Install bearing cups into appropriate bore and tap into place using a suitable mandrel. When housing has cooled (DO NOT cool with water), tap bearing cups to ensure they are fully seated.



27681



73032

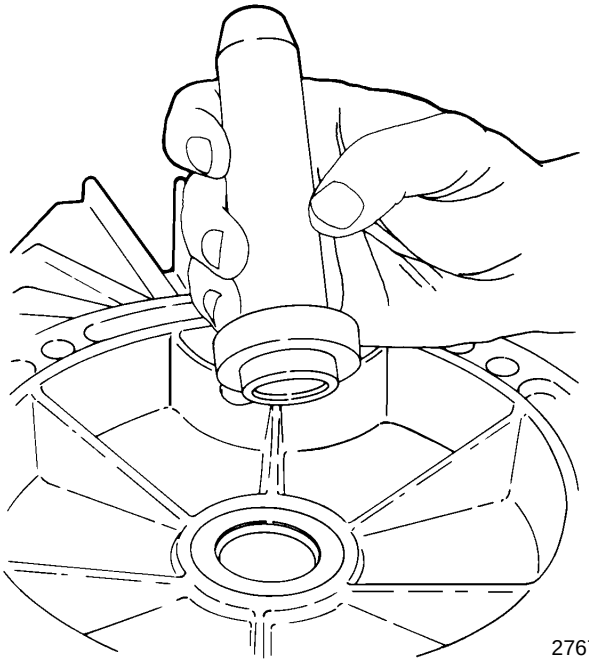
a - Torch Lamp
b - Bearing Cups

Final Assembly

INPUT SHAFT SEAL

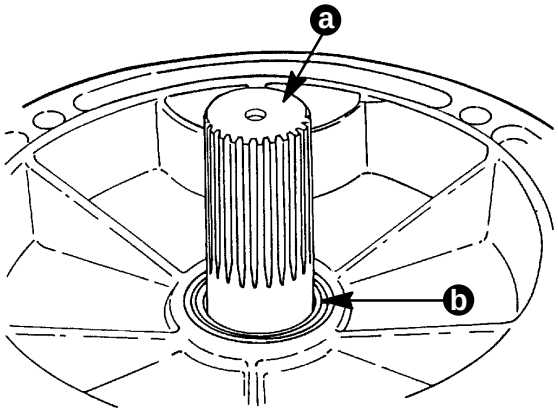
1. Push new seal onto special mandrel. Ensure seal will be positioned with lip of seal facing inward.

   Drive seal uniformly into bore of housing to the point that it is countersunk .040 in. (1 mm) with reference to housing surface.



27670

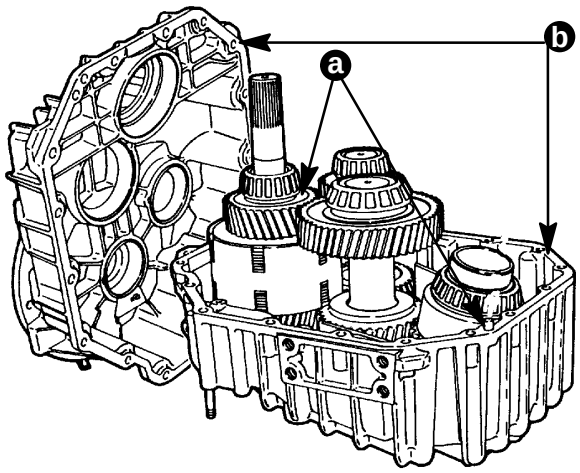
IMPORTANT: Transmissions with 2.0 or 2.5 Gear Ratios - The input shaft seal should not be installed until after the input shaft is installed and housing halves have been joined. (The input shaft must be tilted in order to install the other shafts and this could damage the seal.)



73040

a - Input Shaft
b - Seal

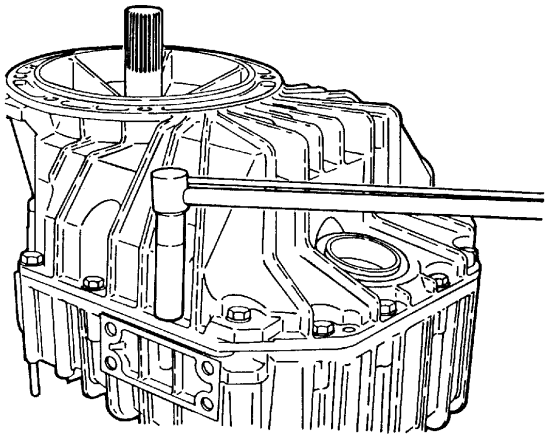
2. Coat lips of seals on input and output shafts with ATF.
3. Apply a thin layer of Loctite 515 Sealer to machined surfaces on housing halves. Reinstall input half of housing. Ensure locator pins are properly positioned.



73019

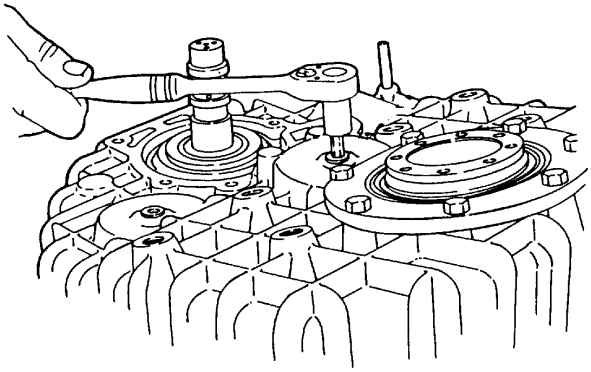
a - Locator Pins
b - Machined Surface

4. Install bolts and lockwashers and torque to 36 lb. ft. (49 N·m).



73033

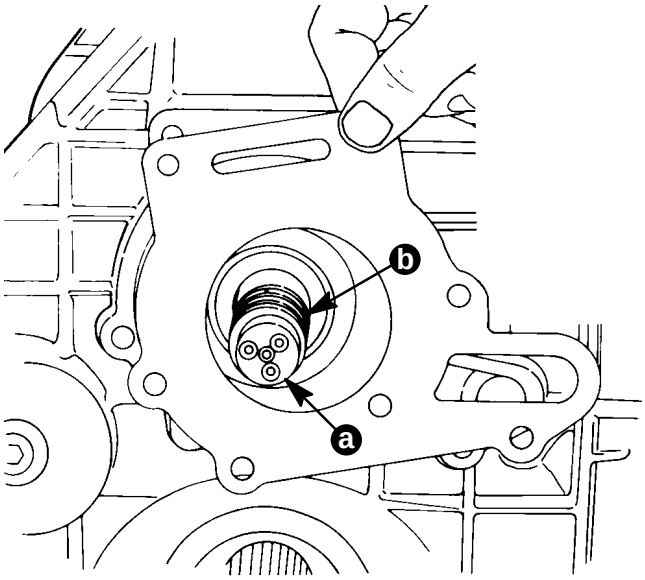
5. Double check to ensure that there is no shaft clearance on all three shafts. Refer back to previous steps if necessary, and use dial indicator.
6. Remove intermediate shaft hex plug. Apply a drop of Quicksilver Loctite Type A to threads and reinstall in housing. Tighten securely.



73041

CONTROL BLOCK

1. Ensure piston rings are in place and the key is in keyway. Align key on shaft with keyway in control block.
2. Install new gasket between control block and housing.

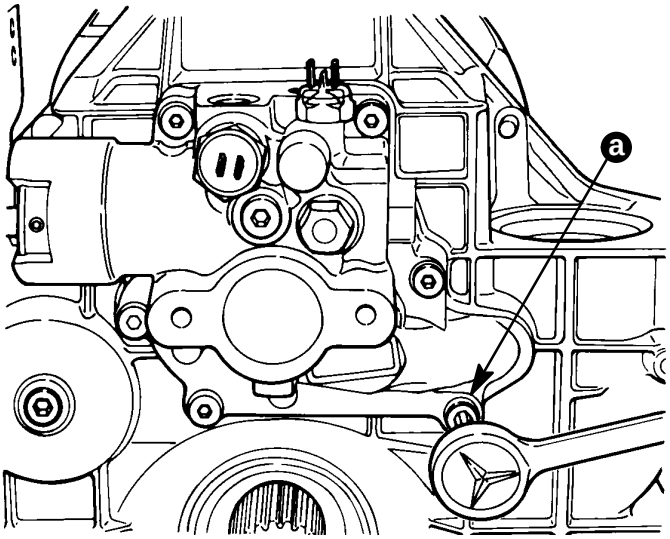


27666

a - Key
b - Piston Rings

3. Carefully push control block onto input shaft.

4. Coat each hex socket head bolt with a drop of Quicksilver Loctite Type A. Secure control block to housing with bolts and lockwashers. Torque to 18 lb. ft. (25 N·m).

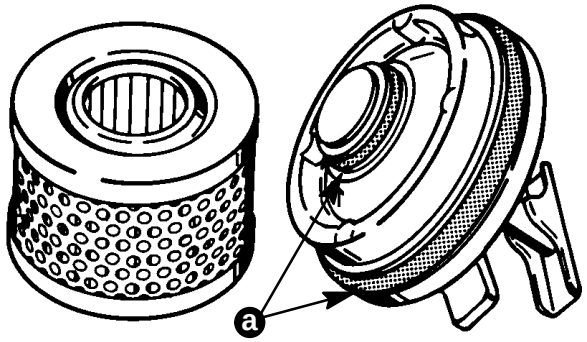


27661

a - Hex Socket Head Bolts (6)

FLUID FILTER

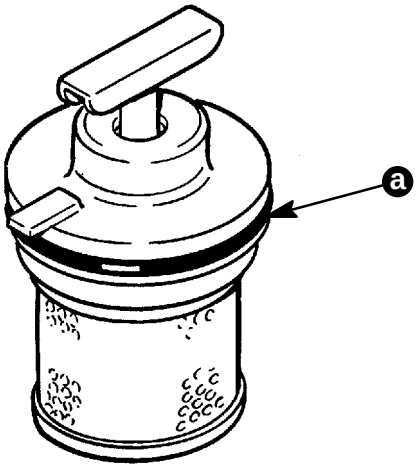
1. Coat new O-rings with ATF.



50975

a - O-Rings

2. Reassemble filter assembly as shown. DO NOT tighten and compress upper O-ring.

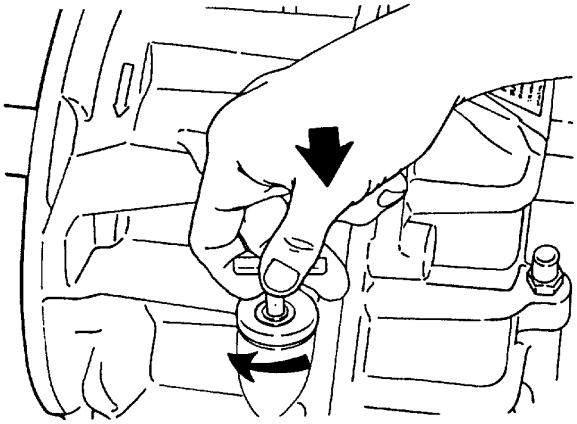


72805

a - O-Rings

DIPSTICK

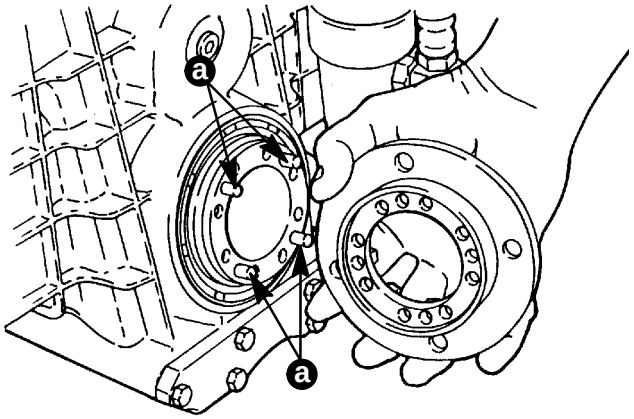
1. Coat sealing ring on dipstick with ATF.
2. Install dipstick into transmission and tighten by pressing down and turning clockwise at the same time.



73042

OUTPUT FLANGE

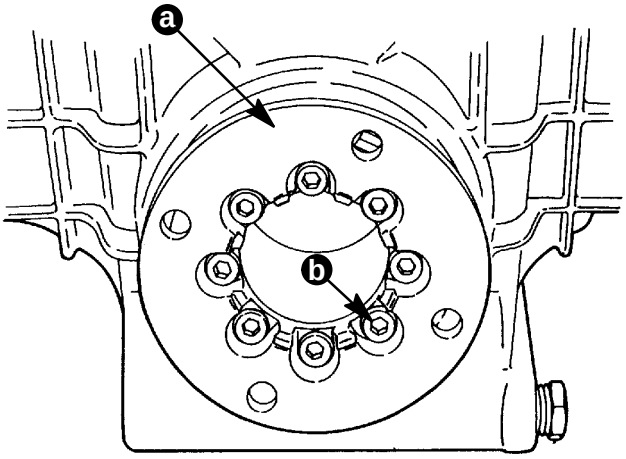
1. Install locator pins into output shaft.



73017

a - Locator Pins (4)

2. Install flange on output shaft. Apply Loctite Type A to threads of bolts and torque to 14 lb. ft. (18 N·m).

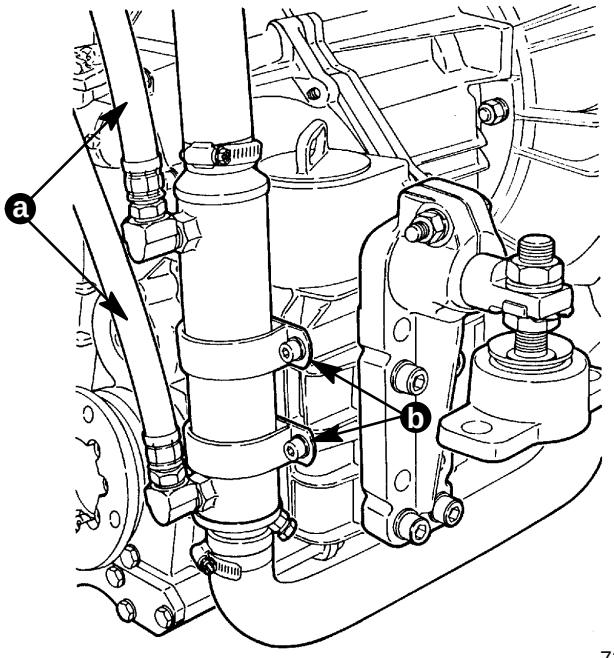


73013

a - Flange
b - Bolts (6)

TRANSMISSION FLUID COOLER

1. Install transmission fluid cooler on housing. Secure with clamps and screws as shown. Torque to 18 lb. ft. (25 N·m).
2. Connect transmission fluid hoses to cooler as shown. Tighten securely.



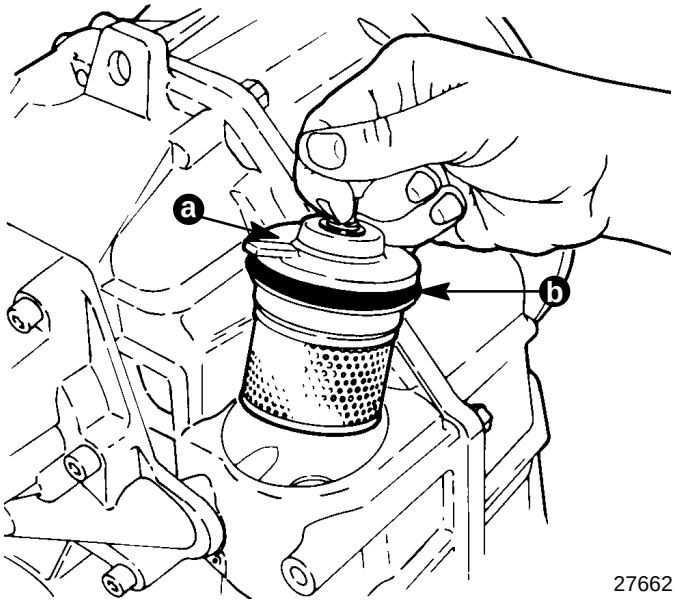
72711

a - Transmission Fluid Hoses
b - Clamps

FILLING WITH TRANSMISSION FLUID

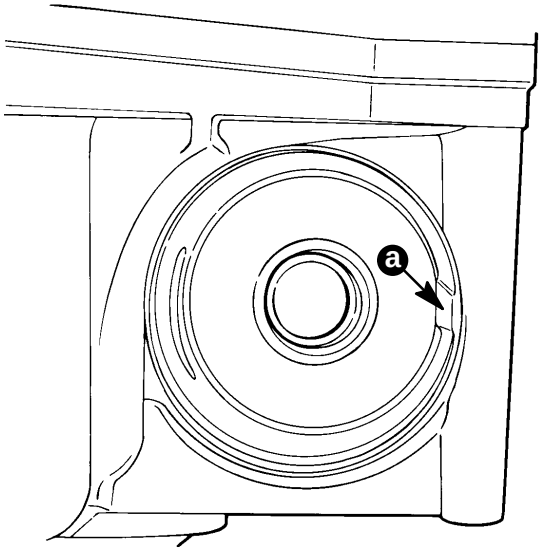
IMPORTANT: Use only ATF (Automatic Transmission Fluid), such as Dexron II or Dexron III.

1. Fill transmission to proper level, through fluid filter cavity. (Refer to “Capacity.”)
2. Install filter as follows:
   a. Bring flat spot on filter into agreement with flat surface inside of housing.
   b. Tighten filter by pushing down and turning clockwise at the same time.

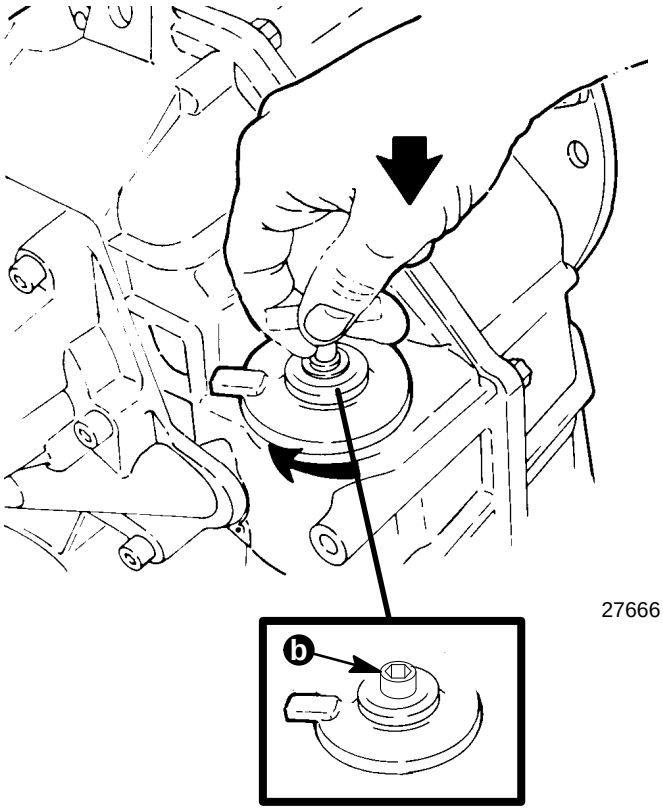


27662

a - Filter Cover
b - O-Ring



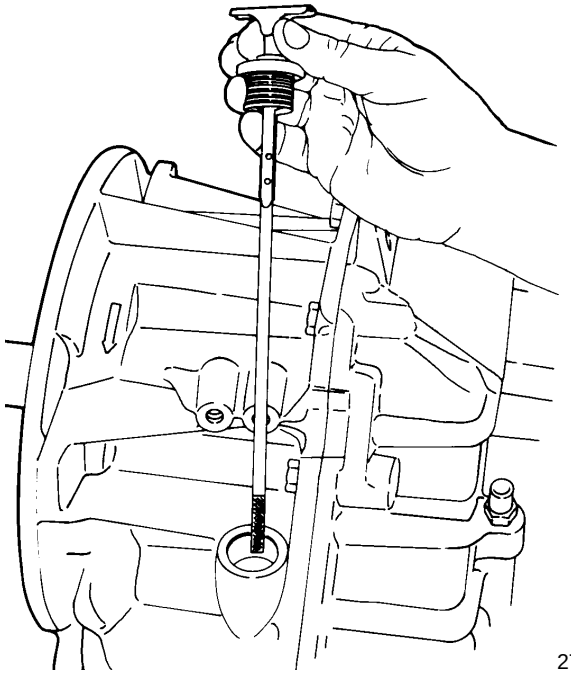
27666



27666

a - Flat Spot
b - Set Screws (Later Models)

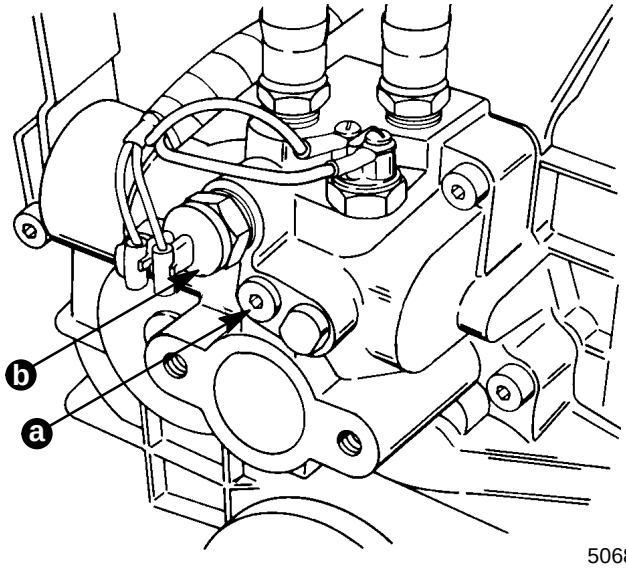
3. Check fluid level. Fluid should be between min. and max. marks on dipstick.



27661

Functional Test

1. Connect a pressure gauge and thermometer to fluid pump at locations shown.



50686

a - Pressure Gauge (m10x1 Thread - Remove Plug)
b - Thermometer (3/8 In. Thread) - Remove Temperature Sender

2. Perform functional tests as shown in chart following. Refer to “Operating Specifications” for correct readings.

Tests to Be Carried Out:

1. Leakages
2. Noise emission
3. Direction of rotation, LH/RH
4. Fluid temperature
5. Shifting pressure

Motor Speed RPM	Shift Lever Position	Duration Minutes	Tests
800-1000	Neutral	5	1 2
600-800 (Idling Speed)	A↔B Position Repeatedly	—	1 2 3
1500-2500	B Position	*	1 2 4
600-800 (Idling Speed)	A↔B Position Repeatedly	—	1 2 3
Idling Maximum Speed	A Position	—	1 2 5**
600 -800	From A → B Position	—	1 2
Idling Maximum Speed	B Position	—	1 2 5**

*Until fluid temperature of 167-176°F (75-80°C) has been reached

**At different speeds

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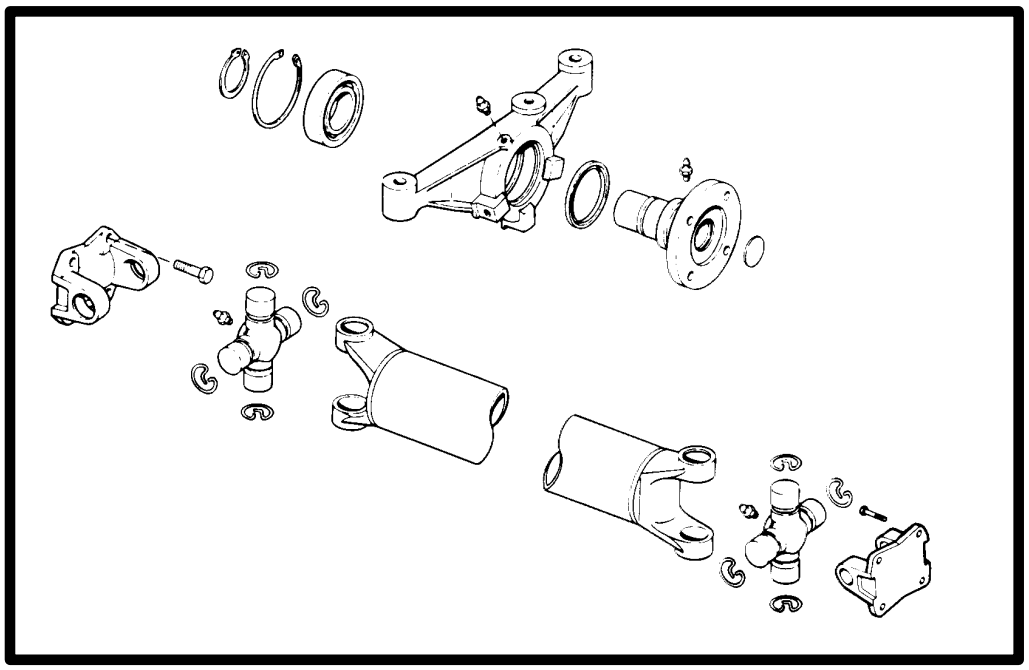
THIS PAGE IS INTENTIONALLY BLANK TO ALLOW FOR CORRECTIONS OR ADDITIONS AT A LATER DATE

DRIVES



DRIVE SHAFT / PROPELLER SHAFT MODELS

8

E

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Torque Specifications

Fastener Location	Lb. Ft.	N·m
Drive Shaft To Bearing Support Flange (MCM Models)	50	68
Drive Shaft To Output Shaft (MCM Models)		
Propeller Shaft Coupling To Transmission Coupling (MIE Models)		
Flywheel Housing To Block (MCM Models)	30	41
Output Shaft Housing To Fly-wheel Housing (MCM Models)		
Engine Coupling	35	48
Coupling Setscrews (If Equipped)	Securely (NOTE)	

NOTE: *Safety wire set screws.*

Tools/Lubricants/Sealants

Description	Part Number
Quicksilver Alignment Tool	91-805475A1
Quicksilver Slide Hammer Puller	91-34569A1
2-4-C Marine Lubricant With Teflon	92-825407A3
U-Joint and Gimbal Bearing Grease	92-828052A2
Quicksilver Engine Coupler Spline Grease	91-816391A4
Quicksilver Loctite 8831	92-823089-1
Loctite 290	Obtain Locally

Flywheel Housing/Output Shaft Housing Repair (MCM Stern Drive Models)

NOTICE

The following repair procedure requires removal of the drive shaft. In most cases, because of engine compartment space limitations, the engine also must be removed.

Removal and Installation

1. Remove drive shaft as outlined following in this section.
2. If engine must be removed, refer to appropriate instructions in Section 2, “Removal and Installation.”

Disassembly

IMPORTANT: This disassembly procedure, beginning with Step 1, assumes that engine does not require removal from boat. If, however, engine removal is required, refer to Section 2 for removal and installation instructions. With engine removed from boat, proceed with disassembly, beginning with Step 3.

1. Support rear of engine with overhead hoist or wooden blocks under the rear of the engine.
2. Remove stringer bolts (rear engine mounts).
3. Remove output shaft housing attaching screws, then remove housing.
4. Remove snap ring, then pull output shaft out of housing.
5. Remove snap ring from housing.
6. Using Quicksilver Slide Hammer Puller, remove bearing from housing.
7. Remove flywheel cover.
8. Remove flywheel housing.
9. Remove engine coupling.
10. Clean and inspect all parts. Replace any damaged parts.

Reassembly

1. Install engine coupling. Torque to 35 lb. ft. (48 N·m).
2. Install flywheel housing. Torque to 30 lb. ft. (41 N·m).
3. Using new gasket, install flywheel cover. Tighten screws securely.

IMPORTANT: Groove in outside diameter of ball bearing must align with grease fitting hole.

4. Install ball bearing into output shaft housing, then install snap ring.
5. Apply Quicksilver 2-4-C Marine Lubricant With Teflon to O-rings (on output shaft), then slide shaft through bearing. Secure shaft with snap ring.
6. Apply Quicksilver Engine Coupler Spline Grease to splines on output shaft.
7. Install output shaft housing to flywheel housing. Torque screws to 30 lb. ft. (48 N·m).
8. Secure rear engine mounts to stringer with bolts. Tighten securely.
9. Remove hoist (or wooden blocks).
10. Install drive shaft and check alignment. (Refer to Section 2 for engine and drive shaft alignment if engine was removed.)

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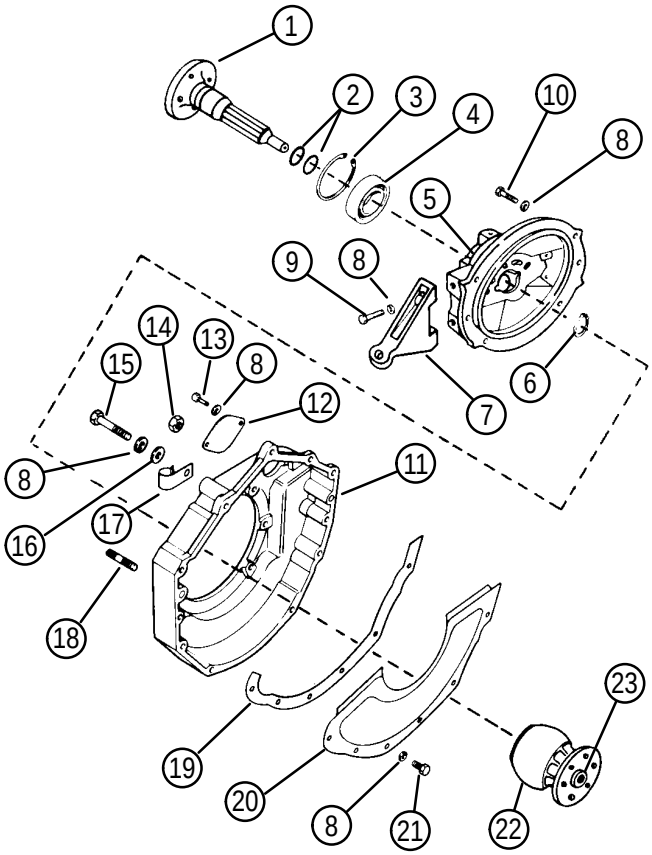
11. Using Quicksilver U-Joint and Gimbal Bearing Grease, grease ball bearing through grease fitting.



Flywheel Housing/Output Shaft Housing

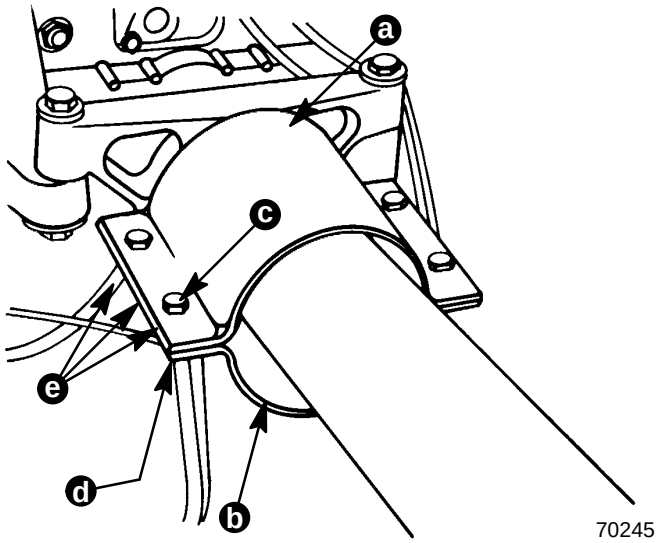
1 - Output Shaft
2 - O-Rings
3 - Snap Ring - Ball Bearing
4 - Ball Bearing
5 - Shaft Bearing
6 - Snap Ring - Output Shaft
7 - Rear Engine Mount
8 - Lockwasher
9 - Screw (4)
10- Screw (6)
11- Flywheel Housing
12- Plate
13- Screw (2)
14- Nut (1)
15- Bolt (4)
16- Washer (1)
17- Clamp (1)
18- Stud (1)
19- Gasket
20- Cover - Flywheel
21- Screw (7)
22- Coupling - Engine
23- Bushing

Drive Shaft Repair (MCM Stern Drive Models)

Removal

IMPORTANT: It is not necessary to remove the engine to service the drive shaft.

1. Remove top and bottom drive shaft shields around transom end and engine end of drive shaft.

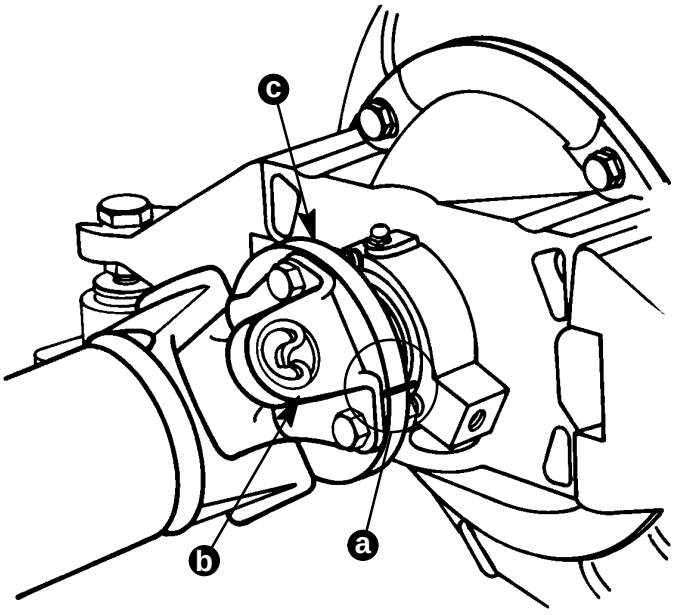


Top Shield and Bottom Shield at Transom End (Engine End Similar)

a - Top Shield
b - Bottom Shield
c - Bolt 3/3-16 x 7/8 In. (22.2 mm); 4 Used
d - Nut 3/8 16: 4 Used
e - Screws (3 Used Hidden In This View)

Index

2. Suitably mark drive shaft U-joint yokes/flange connections (engine output and drive unit input) to assist in exact same positioning during assembly at engine and transom end.

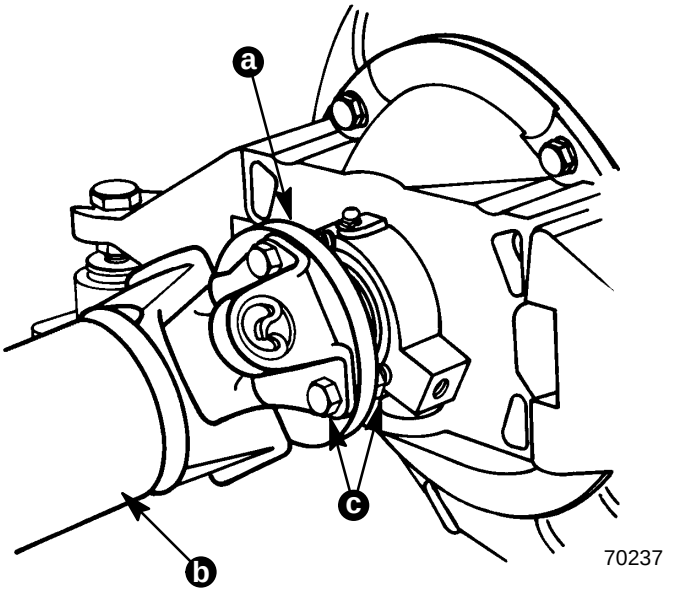


70237

Engine End Shown (Transom End Similar)

a - Suitable Mark On Flange and Drive Shaft Connection
b - Extension Drive Shaft U-Joint Yoke
c - Flange

3. Remove drive shaft fasteners and drive shaft.



70237

Engine End Shown (Transom End Similar)

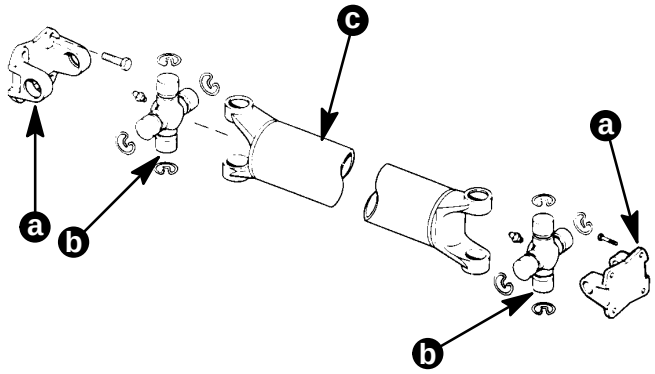
a - Output Shaft Flange
b - Drive Shaft
c - Bolt With Nut (4 Total)

Repair

⚠CAUTION

Be sure U-joint locking rings are seated properly after replacing U-joints.

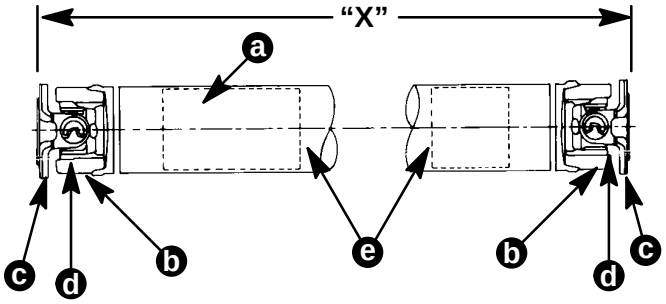
1. Replace U-joints, if required.
2. Replace flange, if required.



a - Flange
b - U-Joint
c - Drive Shaft

Replacement Drive Shafts

MerCruiser furnishes a 58 in. (1473 mm) or 34-1/2 in. (876 mm) long drive shaft with extension shaft models. Some boat manufacturers modify the drive shafts to a shorter length. Because of this, use the following procedure to obtain replacement drive shafts.



a - Tube
b - Yoke - Tube
c - Flange
d - Universal Joint
e - Sound Deadener (Cardboard Tube)

The complete drive shaft can be ordered from Mercury Marine.

Drive Shafts Modified to Shorter Lengths

The complete modified (shortened) drive shaft has to be ordered from the boat manufacturer that installed the MerCruiser Power Package.

IMPORTANT: Dana Corporation - Spicer Regional Drive Shaft Centers will not shorten replacement drive shafts for dealers or consumers.

If a boat manufacturer is currently having extension drive shafts modified, they must be modified by one of Dana Corporation - Spicer Regional Drive Shaft Centers to maintain MerCruiser warranty. The modified drive shaft must meet the following specifications.

- U-joints aligned radially within 0° (± 1/2°).
- U-joints greased, after welding, with Quicksilver U-Joint and Gimbal Bearing Grease.
- Assembly balanced to within 1.5 oz. in. (0.01 N·m) to 4500 RPM.
- Tube to have .005 in. (0.127 mm) to .010 in. (0.254 mm) interference fit with tube yoke.
- Tube must be straight and round within .015 in. (0.381 mm).

Installation

IMPORTANT: The following instructions are to be used if ONLY the drive shaft was removed for service. Refer to appropriate sections for installation of other components which require special alignment.

1. Grease both drive shaft universal joints with Quicksilver U-Joint and Gimbal Bearing Grease.

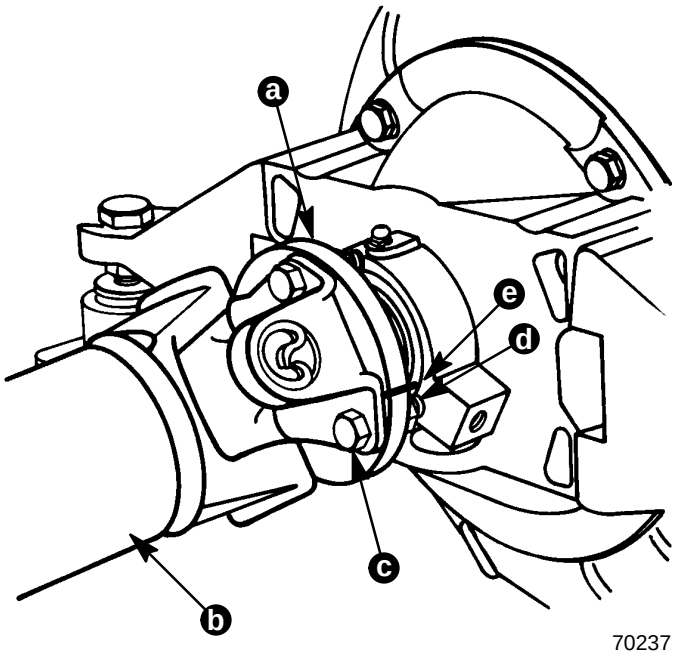
⚠ CAUTION

When attaching shaft in next step, BE SURE that the pilot on drive shaft flanges are engaged in input shaft and output shaft flanges. Flanges MUST BE flush with each other prior to tightening screws or screws may come loose during operation.

⚠ CAUTION

Failure to properly align shaft flanges with matching marks made on disassembly may cause improperly aligned drive unit and extension drive shaft U-joint centerlines resulting in a severe vibration problem.

2. As shown, attach drive shaft output flange and input shaft flange exactly as marked upon disassembly. Torque fasteners to 50 lb. ft. (68 N·m).

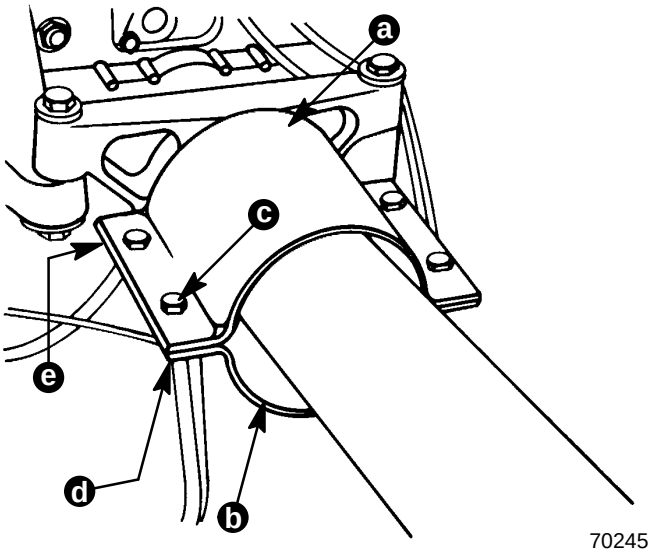


70237

Engine End Shown (Transom End Similar)

a - Output Shaft Flange
b - Drive Shaft
c - Screw 7/16-20 x 1-1/2 In. (38 mm) Long (4 Used)
d - Nut 7/16-20 (4 Used)
e - Suitable Matching Marks Made upon Disassembly - Aligned

3. Apply Loctite 271 to threads of bottom drive shaft shield retaining screws and install bottom shields on engine and transom end. Then install both top shields as shown. Torque all fasteners to 30 lb. ft. (41 N·m).



70245

Top Shield and Bottom Shield at Transom End (Engine End Similar)

a - Top Shield
b - Bottom Shield
c - Bolt 3/8-16 x 7/8 in. (22 mm); 4 Used
d - Nut 3/8-16; 4 Used
e - Screws (3 Used - Hidden in This View)

Bearing Support Repair (MCM Stern Drive Models)

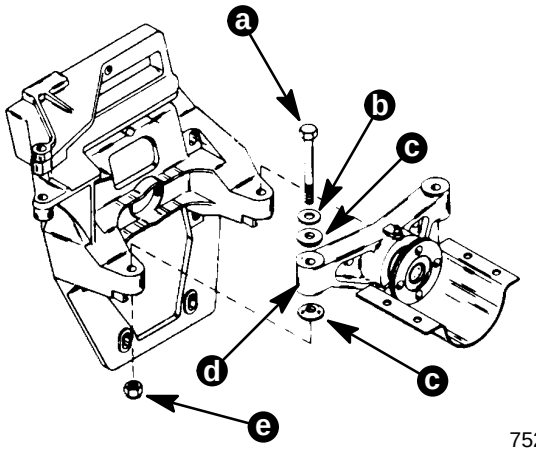
Removal

IMPORTANT: It is not necessary to remove the engine to service the drive shaft and/or bearing support.

⚠CAUTION

If bearing support is removed, you must remove the stern drive unit so you can properly align drive unit U-joint centerline with extension drive shaft U-joint centerline. Lack of alignment will cause a severe vibration problem.

1. Remove drive shaft as previously outlined.
2. Remove stern drive unit (refer to appropriate Stern Drive Service Manual).
3. Remove bearing support and retain hardware.



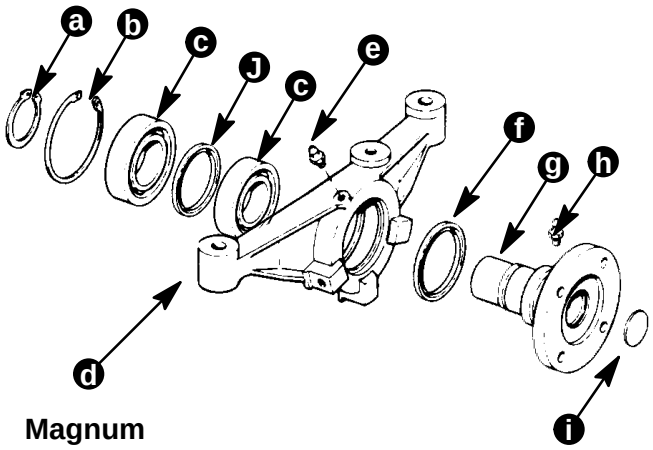
75279

a - Bolt, Bearing Support (2)
b - Flat Washer (2)
c - Spherical Washer (4)
d - Bearing Support (Tailstock)
e - Nut (2)

Disassembly

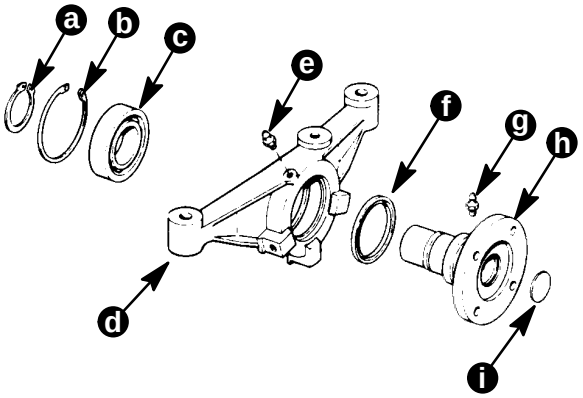
1. Remove snap ring, then remove input shaft.
2. Remove larger snap ring.
3. Using Quicksilver Slide Hammer Puller, remove ball bearing.
4. Remove oil seal.
5. If required, remove plug from end of input shaft.
6. Clean and inspect all parts.

7. Replace any damaged parts.



Magnum

75280



Standard

75281

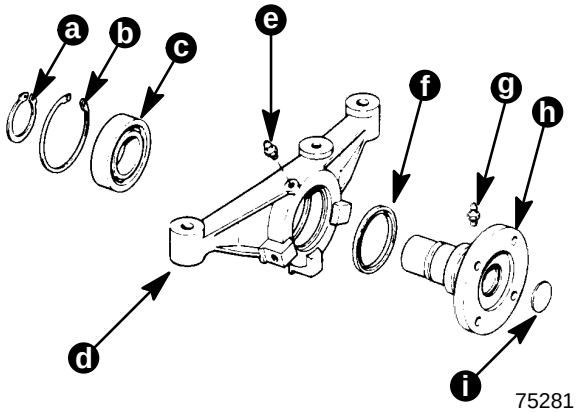
a - Snap Ring - Input Shaft
b - Snap Ring - Ball Bearing
c - Ball Bearing
d - Bearing Support
e - Grease Fitting
f - Oil Seal
g - Grease Fitting
h - Input Shaft
i - Plug - Input Shaft
j - Spacer

Reassembly

1. If removed, install new plug in end of input shaft.
2. Apply Quicksilver Loctite 8831 to outer diameter of new oil seal.
3. Press oil seal into bearing support. Lip of seal faces away from ball bearing.
4. Apply Loctite 290 to outer diameter of ball bearing and inner diameter of bearing support.
5. Install bearing (with sealed side toward snap ring) by using a press. After installation, wipe up excessive Loctite. Install snap ring.
6. Apply Loctite 290 to outer diameter of input shaft (bearing area) and inside diameter of bearing race.
7. Install input shaft, then install snap ring. Wipe up excessive Loctite.

IMPORTANT: Do not let Loctite get into ball bearing.

8. Fill bearing area with Quicksilver U-Joint and Gimbal Bearing Grease through grease fitting.
9. Apply Quicksilver Engine Coupler Spline Grease to splines of input shaft before installing drive unit.



75281

a - Snap Ring - Input Shaft
b - Snap Ring - Ball Bearing
c - Ball Bearing
d - Bearing Support
e - Grease Fitting
f - Oil Seal
g - Grease Fitting
h - Input Shaft
i - Plug - Input Shaft

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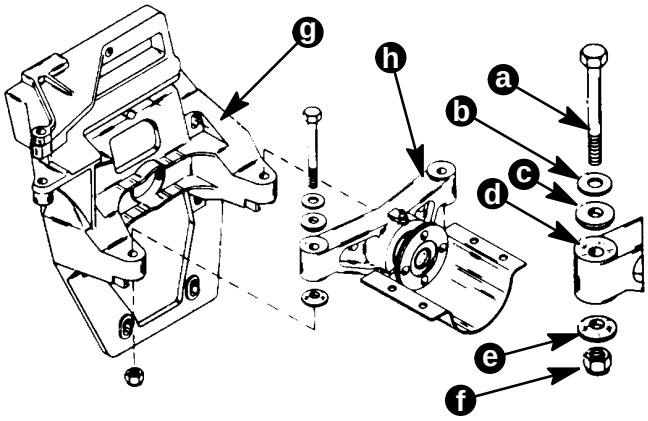
Installation

1. Install bearing support assembly (tailstock) on transom plate using hardware as shown. Tighten bolts until snug. DO NOT TORQUE BOLTS AT THIS TIME.

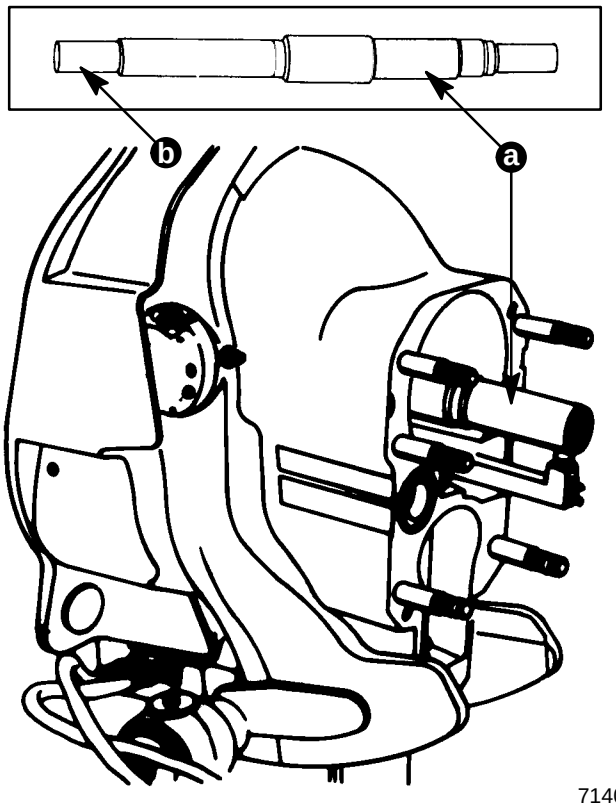
IMPORTANT: The spherical washers MUST BE positioned so that the rounded side of the washers are toward the bearing support assembly as shown.



75279

a - Bolts 1/2-20 x 4 In. (102 mm) Long
b - Steel Washer (Flat)
c - Spherical Washer (Rounded On One Side)
d - Bearing Support
e - Spherical Washer (Rounded On One Side)
f - Nut 1/2-20
g - Transom Plate
h - Bearing Support (Tailstock)

2. Insert solid end of Quicksilver Alignment Tool through bearing in gimbal housing and into input shaft splines of bearing support.



71401

Typical Stern Drive Unit Shown

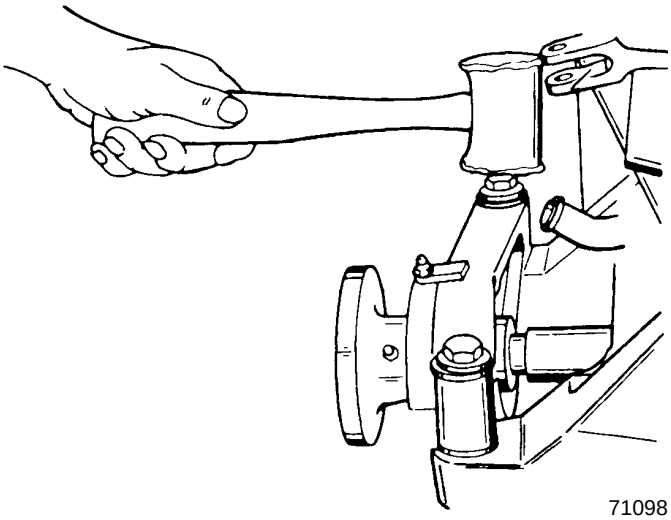
a - Quicksilver Alignment Tool
b - Insert This End Of Alignment Tool Through Gimbal Housing Assembly

3. DO NOT remove alignment tool from gimbal housing.

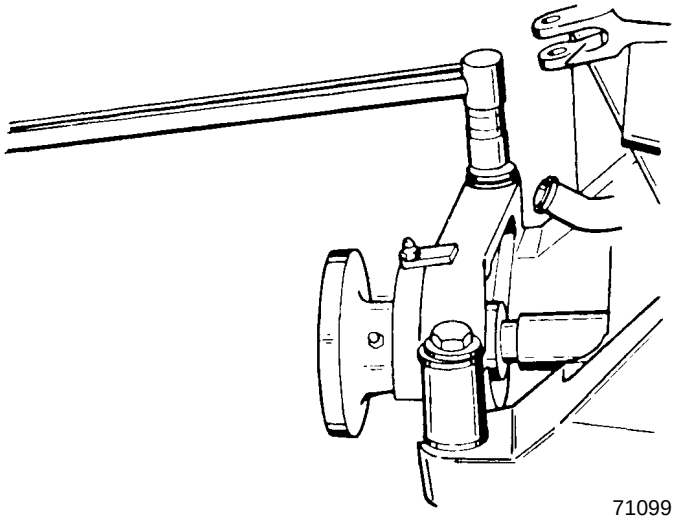
⚠CAUTION

Both attaching bolts MUST BE struck firmly in the following step to properly seat spherical washers. If procedure is not followed, difficulty in the installation of the stern drive may be experienced and subsequent damage to input bearing may result.

4. Strike the head of BOTH bearing support attaching bolts firmly with a hammer.


71098

5. Torque bolts to 35-54 lb. ft. (47-54 N·m) as shown.


71099

6. Refer to appropriate Stern Drive Service Manual and install drive unit.
7. Refer to appropriate Section 2 - “Removal and Installation - Engine Installation/Alignment,” if engine was removed.

Propeller Shaft (MIE Inboard Models)

NOTICE

The following information can be used as a guide for determining vibration problems on boats powered by inboard engines (MIE models). For installation, alignment and repairs to shafts, struts, shaft logs and rudders, refer to boat manufacturer’s service manual. If boat is equipped with V-drive, or a remote mounted V-drive, refer to Section 8B or boat manufacturer’s service manual for all servicing and troubleshooting. For MIE engine installation and alignment, refer to Sections 2E and 2F.

Checks Made with Boat In Water

1. Disconnect propeller shaft coupling from transmission coupling.
2. Check fit of coupling to propeller shaft.

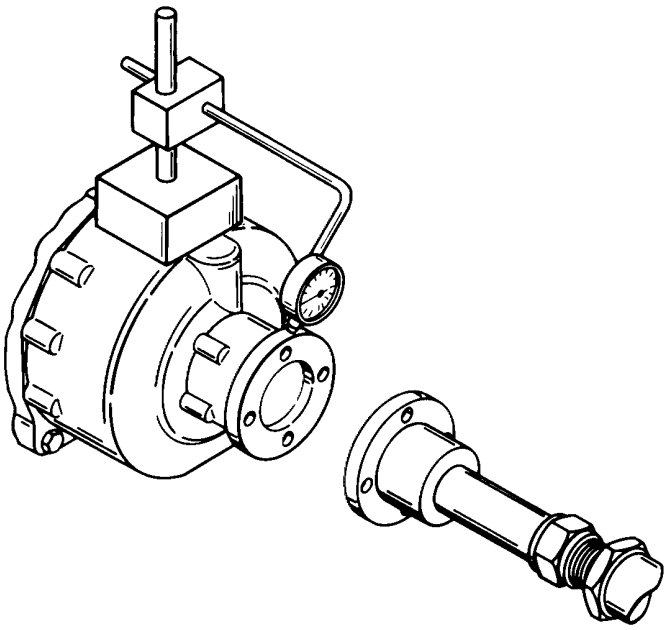
   Straight Bore Type:

   a. Loosen setscrews.
   b. Try to move coupling by hand. The bore of the coupling should be a semi press fit to shaft.
   c. Check shaft for wear. If worn, replacement of shaft may be necessary.
   d. If shaft is not worn, try another coupling.

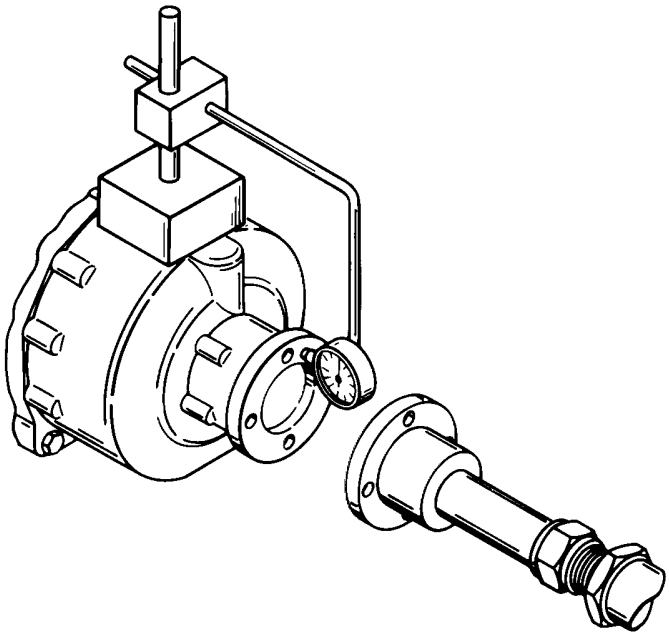
   Tapered Bore Type:

   a. Check nut on shaft for tightness.
   b. If nut was loose, remove coupling and check for damage to taper on shaft or in coupling.
   c. Replace worn parts.
   d. Always make sure key is not sticking out of coupling.
   e. Install coupling on shaft without the key.
   f. Mark the shaft (behind the coupling), then remove the coupling.
   g. Now install the key and coupling. Make sure coupling still lines up with the mark. This ensures that key is not oversize and holding the tapers apart.

3. Check output coupling flange of transmission.



Checking Coupling Outside Diameter - Rotate One Complete Turn



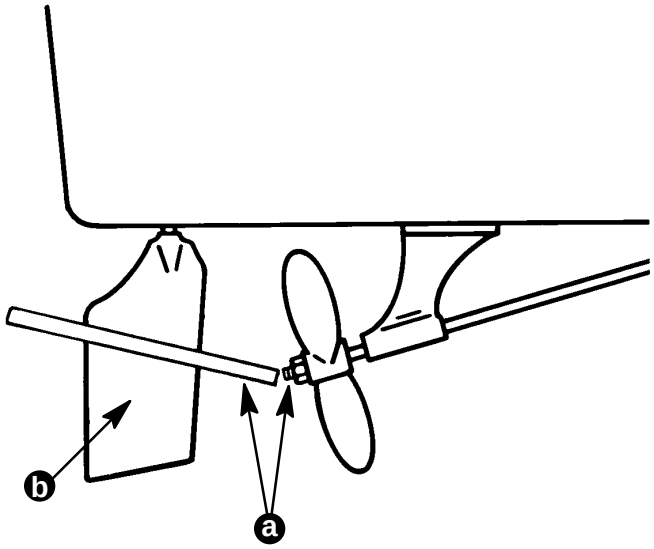
Checking Coupling Face - Rotate One Complete Turn

4. If there is movement in Step 3, replace output coupling.
5. Replace damaged parts and realign engine as outlined.
6. Torque propeller shaft coupling and transmission coupling (output flange) to 50 lb. ft. (68 N·m). Tighten set- screws securely, if so equipped. Safety wire set- screws, if so equipped.

Checks Made with Boat Out of Water and Shaft Installed

Possible causes for vibration may be propeller shaft, propeller to shaft fit or propeller. All three can be checked by using the rudder, a strong metal straight edge and a C- clamp.

1. Check installation of propeller to shaft.
   a. Remove propeller.
   b. Check for chipped or cracked keyway in propeller on shaft without key.
   c. Install propeller on shaft without key.
   d. Mark the shaft (behind the propeller), then remove propeller.
   e. Install the key and propeller. Make sure propeller still lines up with mark. This ensures that key is not oversize and holding the tapers apart. Retighten propeller nut.
   f. Be sure key is not sticking out of propeller.
2. Check for propeller shaft being bent behind the strut.



a - Metal Straight Edge (Held T Rudder With C-Clamp) - Position Corner Of Straight Edge At Center Of Shaft. Rotate Shaft One Complete Turn. If Shaft Wobbles, Replace Shaft.

b - Rudder

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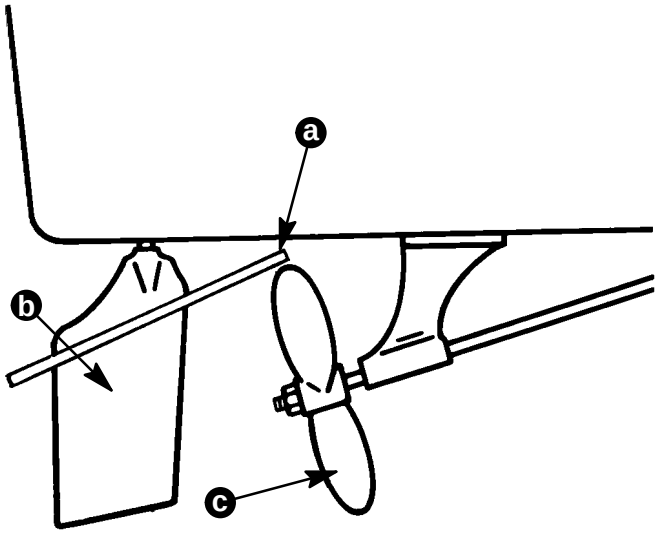
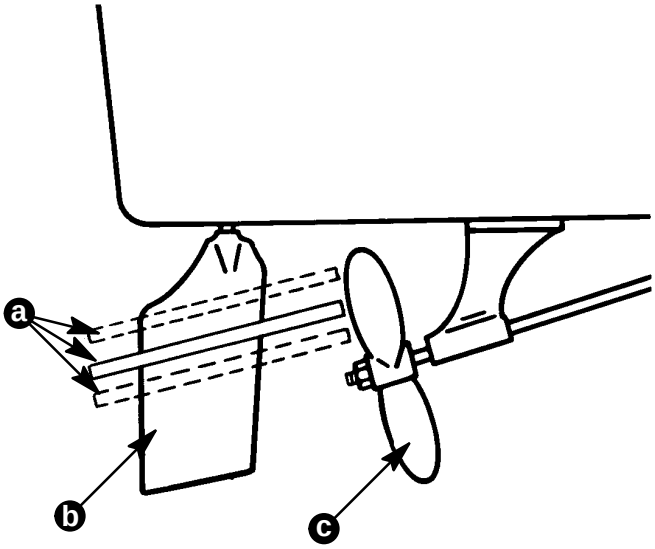
3. Check the diameter of all propeller blades. If not the same, repair propeller.



a - Metal Straight Edge (Held T Rudder With C-Clamp)
b - Rudder
c - Rotate Propeller One Complete Turn

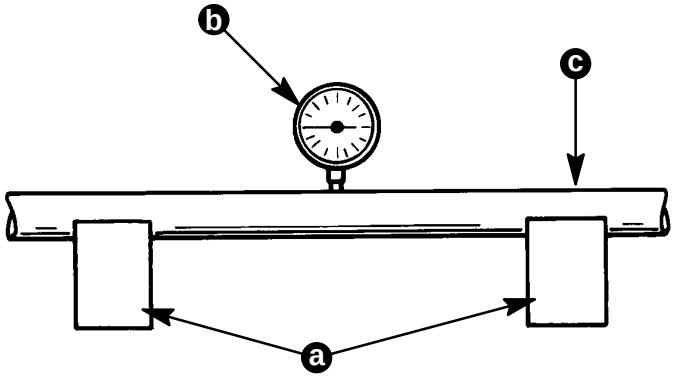
4. Check that all propeller blades are the same pitch and that propeller is properly seated on shaft. Repair or replace if necessary.



a - Metal Straight Edge (Held T Rudder With C-Clamp)
b - Rudder
c - Rotate Propeller One Complete Turn. Check At Three Different Points On Blades

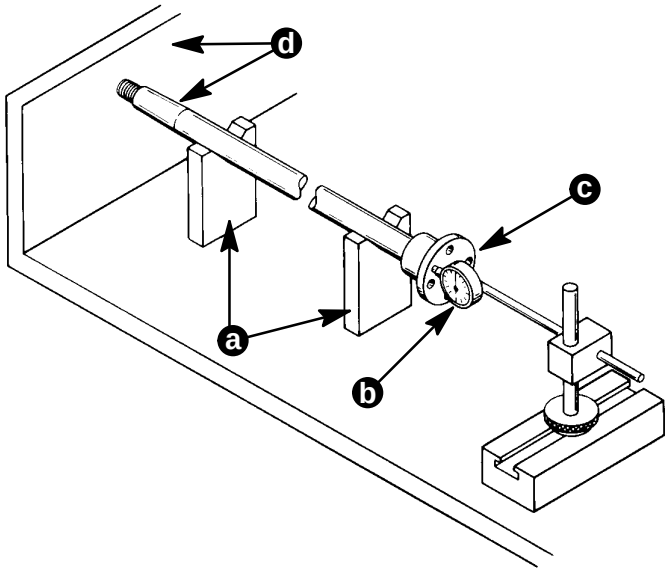
Checks Made with Propeller Shaft Removed from Boat

1. Check propeller shaft for straightness. Check at three or four places. If dial indicator deflects over .004 in. (0.1 mm), replace shaft.



a - V-Blocks
b - Dial Indicator
c - Shaft - Rotate One Complete Turn

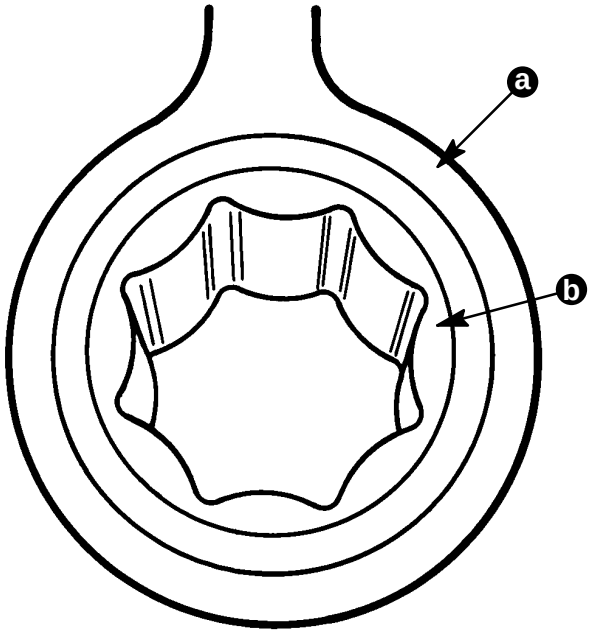
2. Check that bore of coupling is 90 degrees from coupling flange. Replace coupling if needle moves.



a - V-Blocks
b - Dial Indicator
c - Coupling Flange - Rotate One Complete Turn
d - Shaft Against Block To Prevent Fore And Aft Movement

Strut

Refer to boat manufacturer’s service manual for alignment and replacement. Normally, the shaft should be centered in the cutlass bearing. Shims (placed between the strut and hull) are used to align the strut to the shaft.



71091

a - Strut
b - Cutlass Bearing

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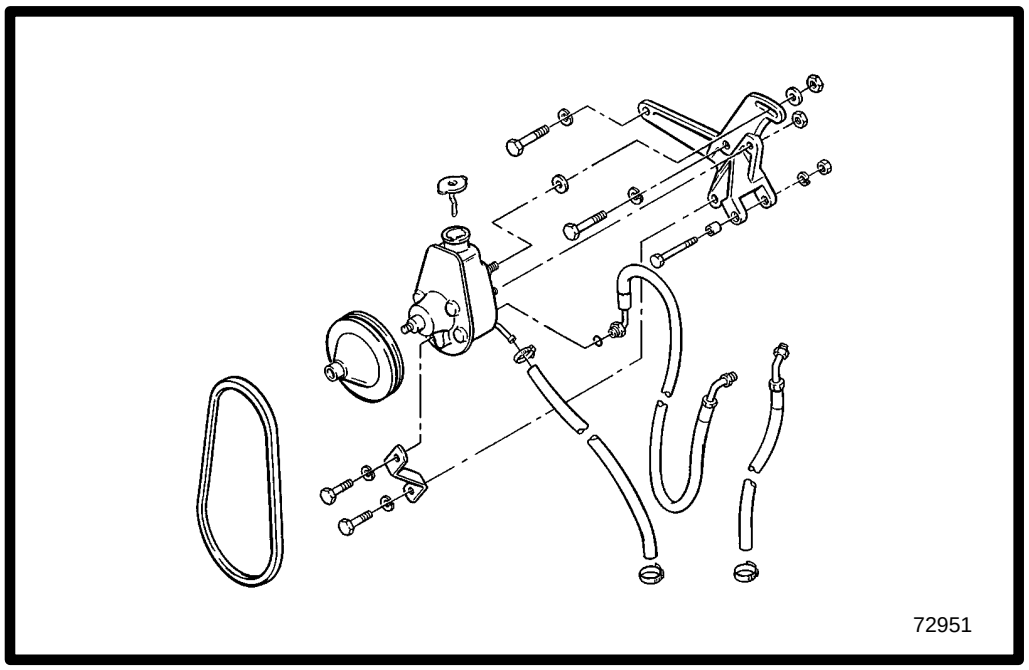
POWER STEERING



PUMP

9

A

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Torque Specifications

Fastener Location		Lb. Ft.	Lb. In.	N·m
Crankshaft Pulley To Torsional Damper		35		42
Torsional Damper To Crankshaft		60		81
Pump Mounting Bracket To Engine		30		41
Recirculation Pump Pulley			240	27
Early Style Power Steering Hose Fittings	Large	20-25		27-34
Early Style Power Steering Hose Fittings	Small		96-108	11-12
Later Style Power Steering Hose Fittings		23		31

Tools/Sealants

Description	Part Number
Pulley Installer	91-93656A1
Quicksilver Perfect Seal	92-34227-1
Pulley Removal Tool (Kent-Moore)	J-25034

Kent-Moore Special Tools
29784 Little Mack
Roseville, MI 48066
(313) 574-2332

Precautions

⚠ CAUTION

Do not operate engine without cooling water being supplied to water pickup pump or water pump impeller will be damaged and subsequent overheating damage to engine may result.

⚠ WARNING

Always disconnect battery cables from battery before working on engine to prevent fire or explosion.

⚠ CAUTION

Do not pry on power steering pump or alternator when adjusting belt tension. Serious damage may result.

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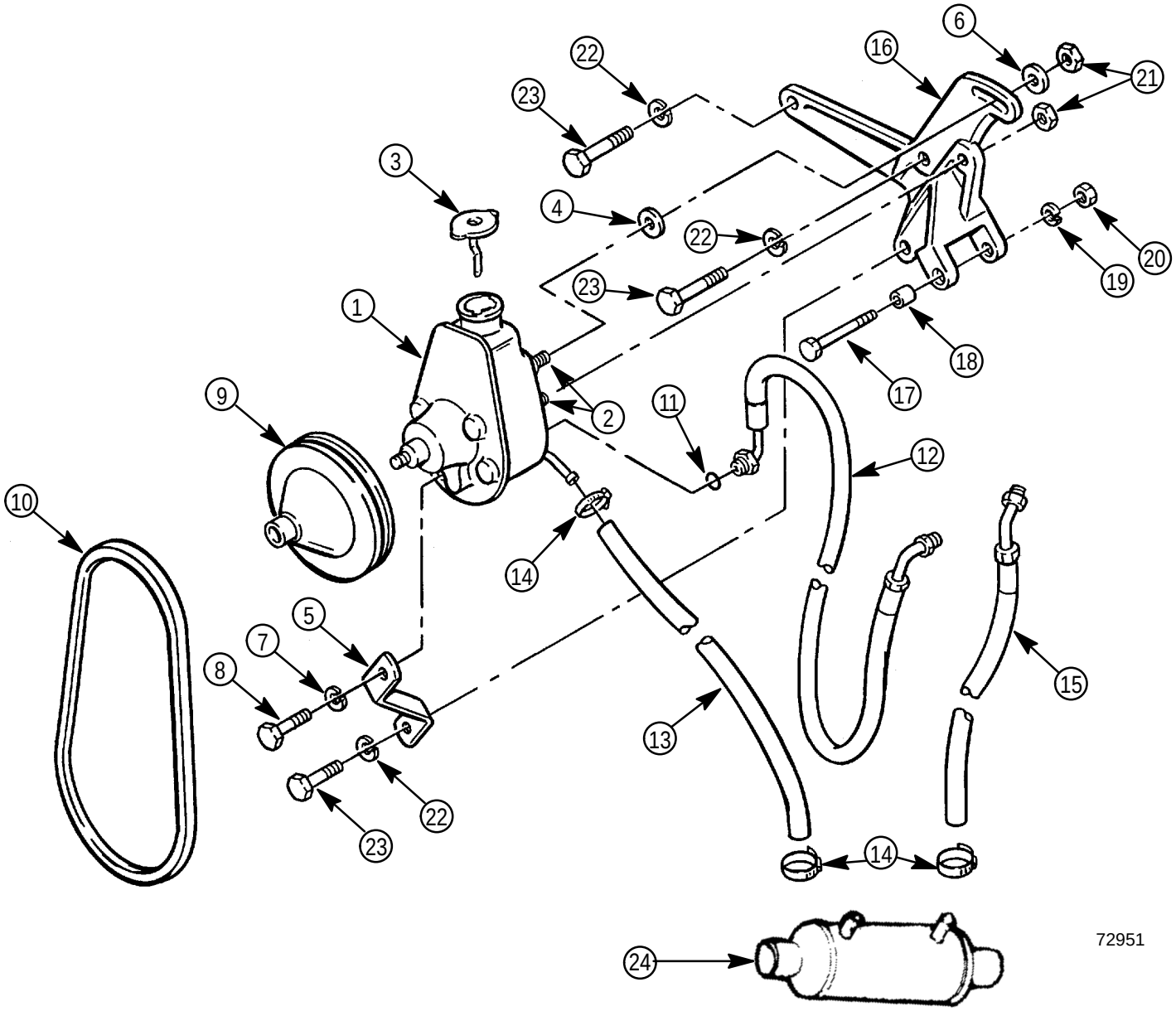
Power Steering Pump and Components (Exploded View)



1 - Power Steering Pump Assembly
2 - Stud
3 - Cap
4 - Spacer
5 - Brace
6 - Spacer
7 - Lockwasher
8 - Bolt, Pump To Brace
9 - Pulley
10- Belt
11- O-Ring, High Pressure Hose Fitting
12- Hose, High Pressure (Fittings on Both Ends)
13- Hose, Pump To Fluid Cooler
14- Clamp
15- Hose, Control Valve To Fluid Cooler (Fitting On One End)
16- Mounting Bracket, Cast
17- Bolt
18- Spacer (Barrel Shaped)
19- Lockwasher
20- Nut (For Item 17)
21- Nut (For Item 21)
22- Lockwasher
23- Bolt To Cylinder Block
24- Power Steering Cooler

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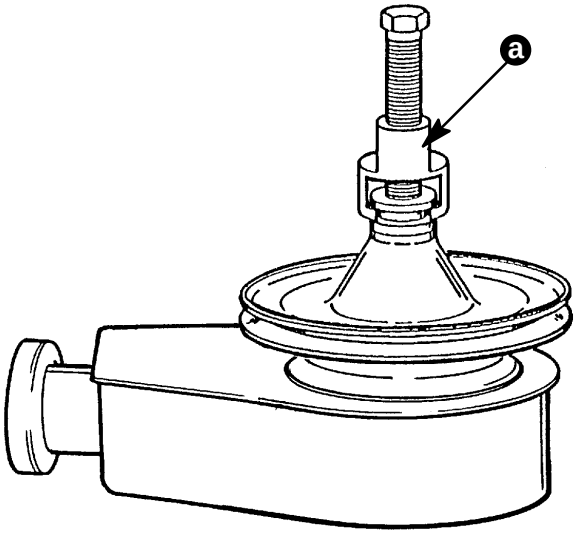
Important Service Information

Pump Pulley Replacement

REMOVAL

IMPORTANT: Kent-Moore Tool J-25034 must be used to remove the pressed-on pulleys used on power steering pumps. This tool has an end on it that will not mushroom the end of the pump shaft. DO NOT use Kent-Moore Tool J-21239 to remove these pulleys. This tool has a tapered end and will damage the shaft.

1. Install Kent-Moore Tool J-25034 on end of pulley and shaft as shown.
2. While holding tool with suitable wrench, turn threaded screw until pulley is removed.



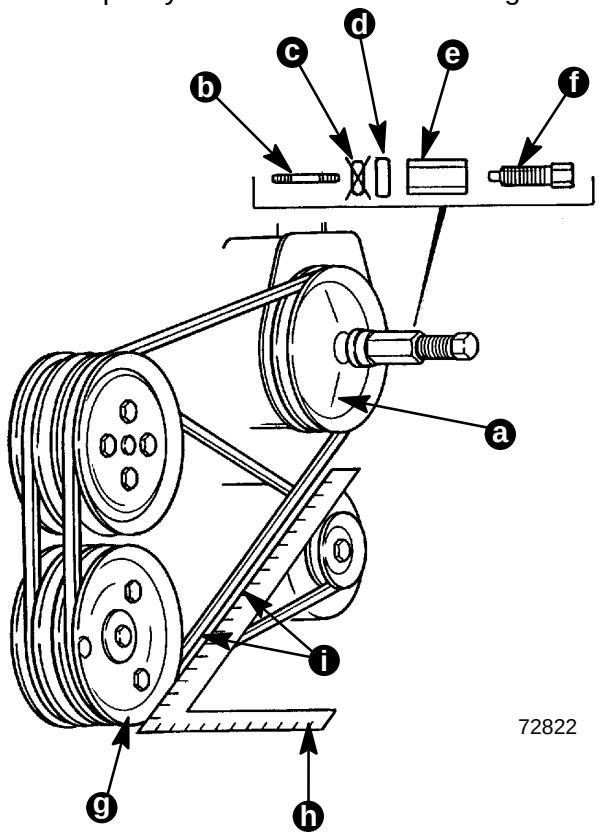
72821

a - Kent-Moore Pulley Removal Tool (P/N J-25034)

INSTALLATION

Install pulley, as follows, using pulley installer tool (P/N 91-93656A1), and a long straight edge:

1. Place pulley on pump shaft.
2. Thread stud all the way into pump shaft. Place bearing over stud. Do not use spacer from kit.
3. Thread nut onto shaft. Thread tool shaft (and nut) all the way onto stud (threaded into pump pulley).
4. Using a long straight edge (to check drive belt alignment), turn large pusher nut until drive belt is parallel to straight edge.
5. Check pulley installation for correct alignment.



72822

a - Power Steering Pump Pulley
b - Stud
c - Do Not Use Spacer
d - Bearing
e - Nut
f - Tool Shaft
g - Crankshaft Pulley (shown) Or Water Circulating Pump Pulley
h - Long Straight Edge
i - Drive Belt Parallel

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Testing and Repair

Refer to appropriate MerCruiser Stern Drive Service Manual.

Checking Pump Fluid Level

Refer to Section 1B - “Maintenance” (see “Table of Contents”).

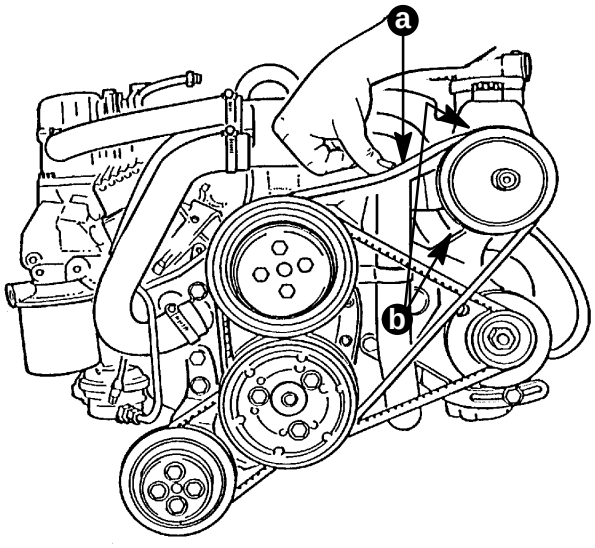
Filling and Air Bleeding System

Refer to Section 1B - “Maintenance” (see “Table of Contents”).

Pump Drive Belt Adjustment

IMPORTANT: Do not pry on power steering pump with pry bar or screwdriver. Serious damage may result.

1. Install drive belt on pulleys and adjust tension as follows:
   a. Pivot pump away from engine, as required, until correct tension is obtained, as shown.
   b. After obtaining correct tension, securely tighten pump brace and pump mounting bolts.
2. If a new drive belt has been installed, recheck belt tension after running for five minutes.



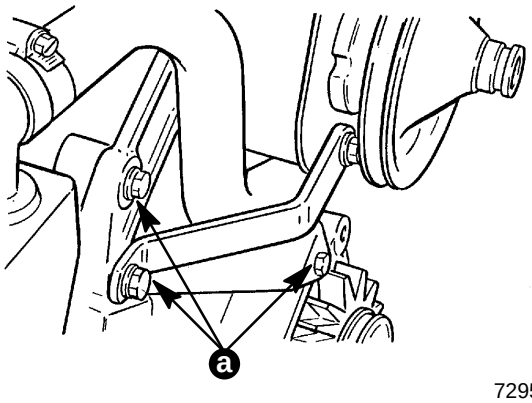
72847

j - Belt Should Depress 1/4 In (6 mm)
k - Screws and Nuts

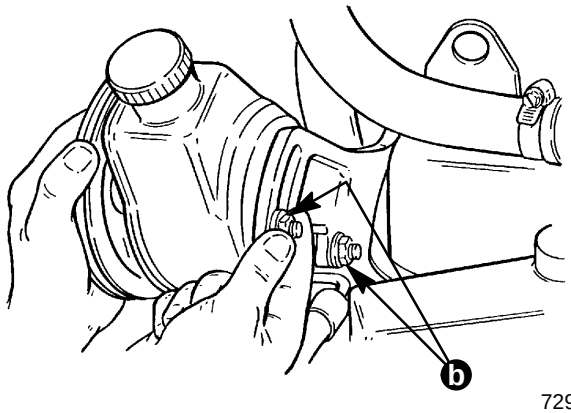
Pump Assembly

Removal

1. Loosen pump brace and pump mounting fasteners. Pivot pump to loosen belt. Remove drive belt.
2. Remove mounting fasteners from pump.



72950



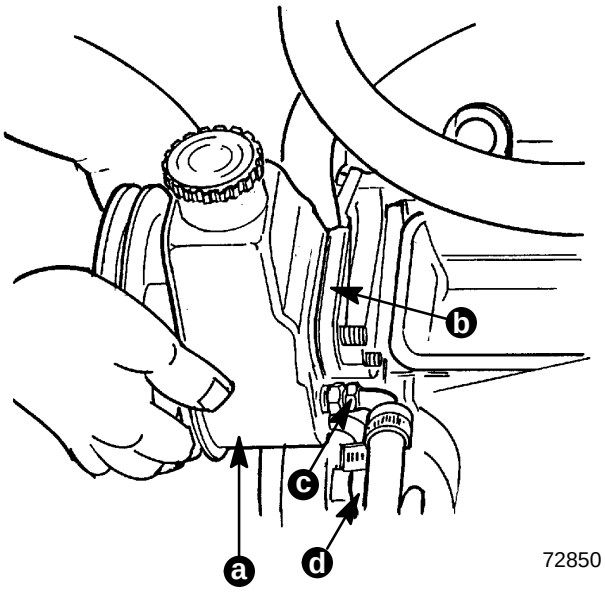
72949

a - Screws
b - Nuts

Index

3. Remove pump assembly from bracket to gain access to fluid hoses.
4. Remove high pressure hose threaded fitting and O-ring. Disconnect low pressure hose from back of pump assembly.

NOTE: *Catch fluid that drains from pump and hoses in a suitable container.*



72850

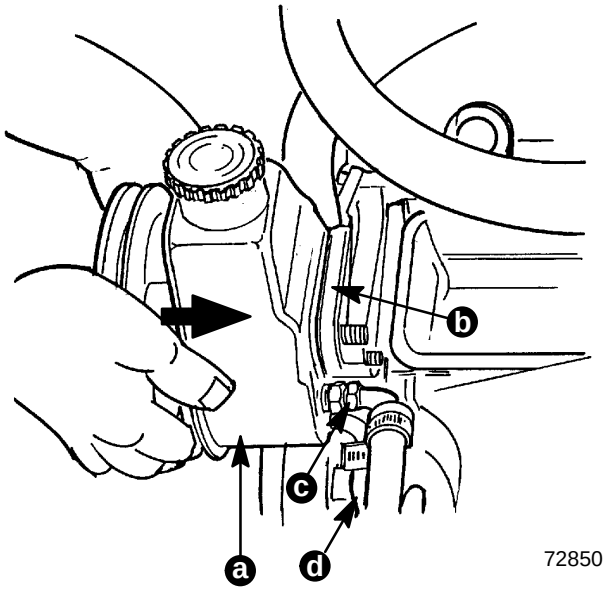
a - Pump
b - Bracket
c - Threaded Fitting
d - Low Pressure Hose

5. Refer to appropriate Stern Drive Service Manual for power steering pump repair procedures.

Installation

IMPORTANT: Be careful to not cross-thread or over-tighten hose fittings.

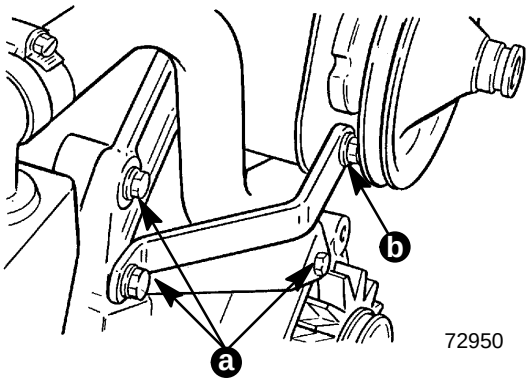
1. Be certain a new high pressure hose O-ring is present, and install threaded fitting in back of pump assembly. Tighten fitting securely. Connect low pressure hose on back of pump. Tighten hose clamp securely.



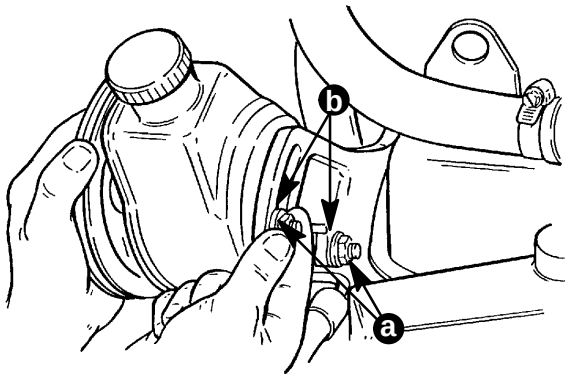
72850

a - Pump
b - Bracket
c - Threaded Fitting
d - Low Pressure Hose

2. Install mounting hardware and fasteners to retain pump to bracket. (Refer to “Exploded View” for specific details on your engine.)



a - Bolt and Lockwasher
b - Metric Bolt and Lockwasher



a - Metric Nuts
b - Washers

3. Install drive belt and adjust tension. Refer to “Pump Drive Belt Adjustment” as previously outlined.
4. Fill and air bleed system. Refer to Section 1B - “Maintenance” (see “Table of Contents”).

Mounting Bracket

Mounting bracket is removable after pump (refer to previous instructions) and alternator (refer to Section 4C - “Charging System”) have been removed. See “Exploded View” and “Torque Specifications.”

Hydraulic Hoses and Fluid Cooler

Refer to Section 6A - “Seawater Cooled Models” or Section 6B - “Closed Cooled Models” for information on testing or servicing power steering fluid coolers. The following is provided to assist in replacement of power steering fluid hoses and to assure proper routing and connection to the cooler.

Replace high or low pressure hoses following:

IMPORTANT: Make hydraulic connections as quickly as possible to prevent fluid leakage.

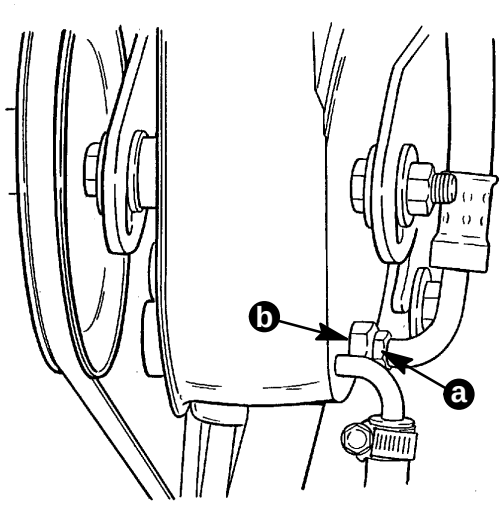
IMPORTANT: Be careful to not cross-thread or over-tighten hose fittings.

High Pressure Hose (Pump-to-Control Valve)

REMOVAL

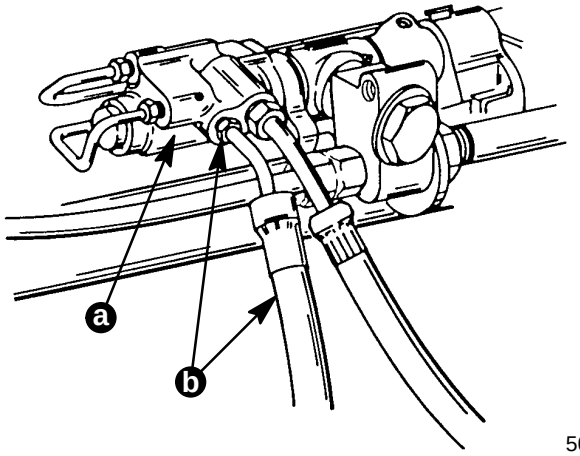
NOTE: *Catch fluid that drains from pump and hoses in a suitable container.*

1. Remove high pressure hose fitting with O-ring seal from pump fitting on rear of pump.



a - High Pressure Hose Fitting (With O-Ring - Not Visible In This View)
b - Pump Fitting

2. Remove hose where routed and secured (port or starboard side), across top of engine, near valve cover.
3. Remove small fitting from control valve at transom. Remove hose.



50912

Early Style

a - Control Valve
b - Small Fitting and Hose

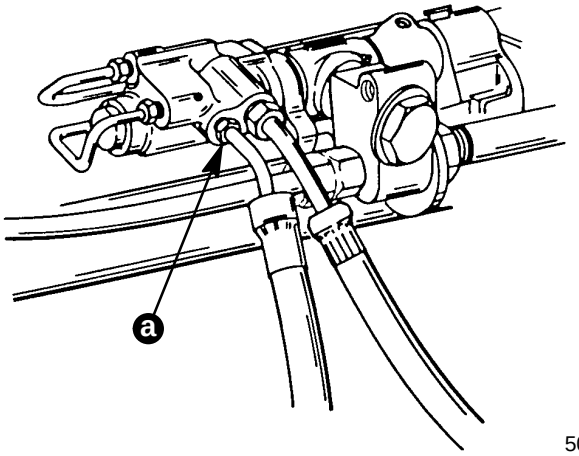
INSTALLATION

⚠CAUTION

Route hoses exactly as shown below. This will help avoid stress on the hose fittings and will help avoid kinks in the hoses.

IMPORTANT: Be careful to not cross-thread or over-tighten hose fittings.

1. Thread small fitting into control valve. Position hose properly (as prior to removal) and torque fitting to 96-108 lb. in. (11-12 N·m). Do not cross-thread or over-tighten.

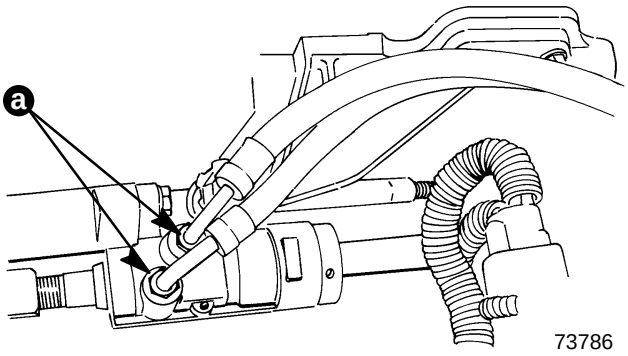


50912

Early Style

a - Small Fitting

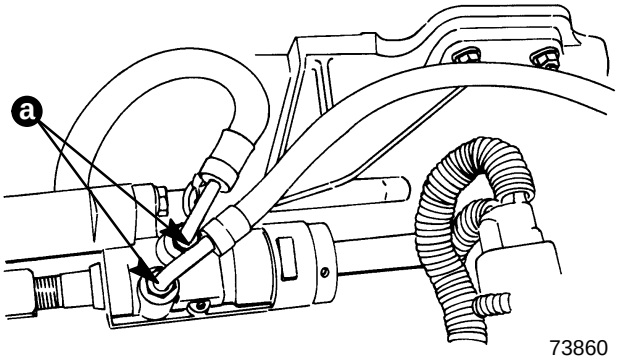
2. If equipped with later style control valve, install fittings and torque to 23 ft. in. (21 N·m).



73786

Later Style - All Models Except 502 Magnum EFI

b - Power Steering Hose Fittings



73860

Later Style - 502 Magnum EFI With return Lines On Starboard Side Power Steering Cooler

a - Power Steering Hose Fittings

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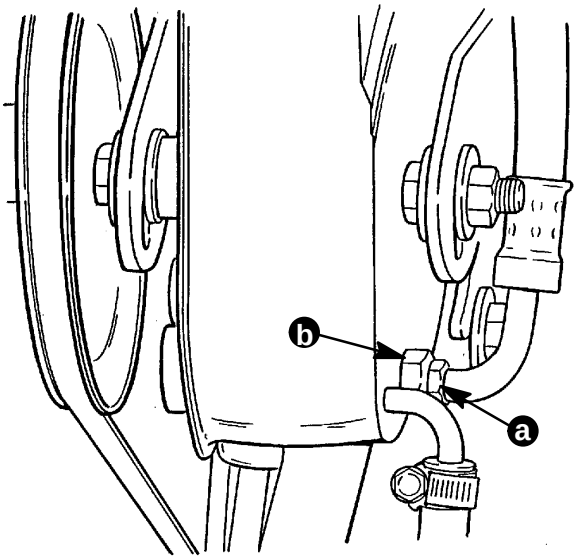
3. Route hose along valve cover and secure with J-clamp(s) provided.
4. Be certain a new high pressure hose O-ring is present, and install threaded hose fitting in back of pump assembly fitting. Tighten hose fitting securely. Do not cross-thread or over-tighten.



72848

a - High Pressure Hose Fitting (With O-Ring - Not Visible In This View)
b - Pump Fitting

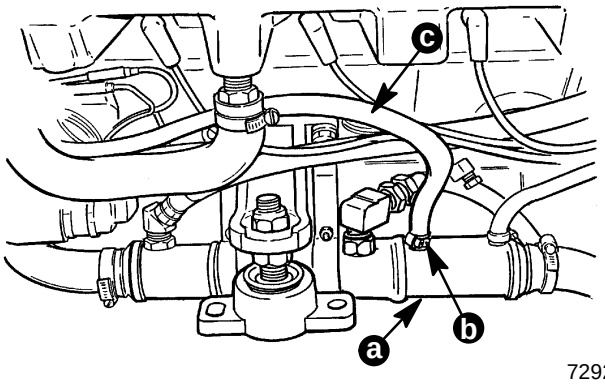
5. Fill and air bleed system. Refer to Section 1B - “Maintenance” (see “Table of Contents”).

Low Pressure Hose (Cooler-to-Pump)

REMOVAL

NOTE: *Catch fluid that drains from hose, cooler and pump in a suitable container.*

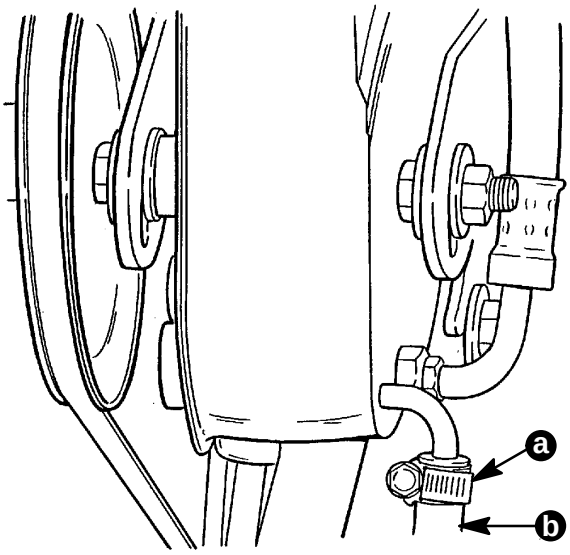
1. Loosen hose clamp and remove hose from fluid cooler.



72925

a - Fluid Cooler
b - Hose Clamp
c - Hose

2. Loosen hose clamp and remove hose from back of pump.

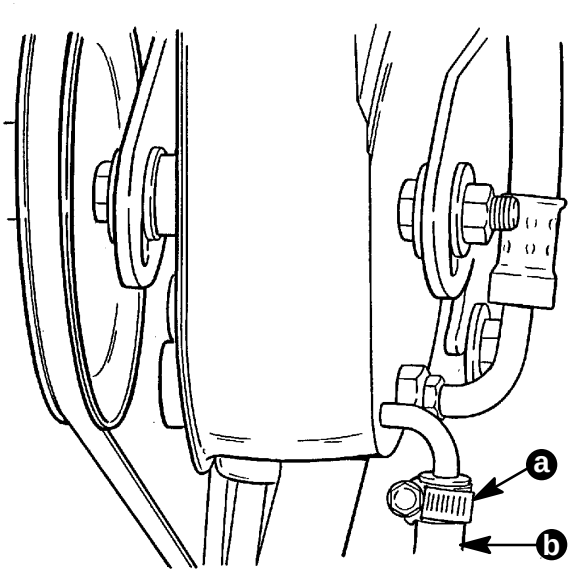


72848

a - Hose Clamp
b - Hose

INSTALLATION

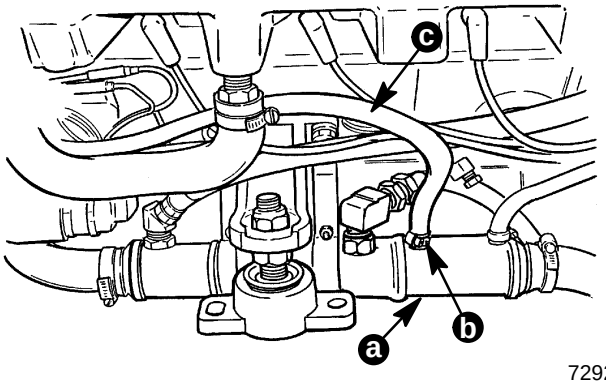
1. Using hose clamp, install new hose on back of pump. Tighten clamp securely.



72848

a - Hose Clamp
b - Hose

2. Using hose clamp, install hose on fluid cooler. Tighten clamp securely.



72925

a - Fluid Cooler
b - Hose Clamp
c - Hose

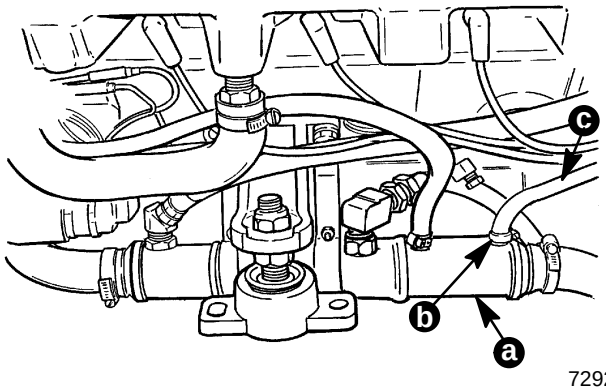
3. Fill and air bleed system. Refer to Section 1B - “Maintenance” (see “Table of Contents”).

Low Pressure Hose (Control Valve-to-Cooler)

REMOVAL

NOTE: *Catch fluid that drains from hose, cooler and pump in a suitable container.*

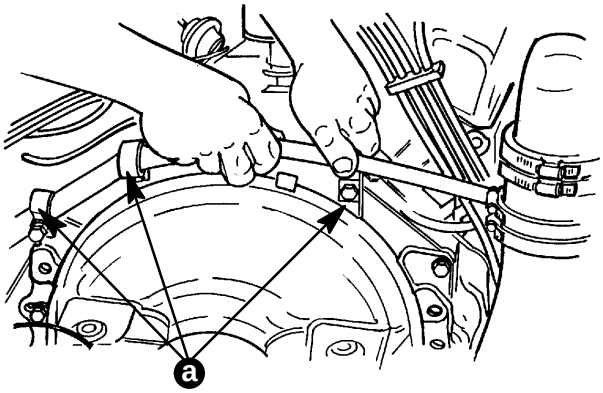
1. Loosen hose clamp and remove hose from fluid cooler.



72925

a - Fluid Cooler
b - Hose Clamp
c - Hose

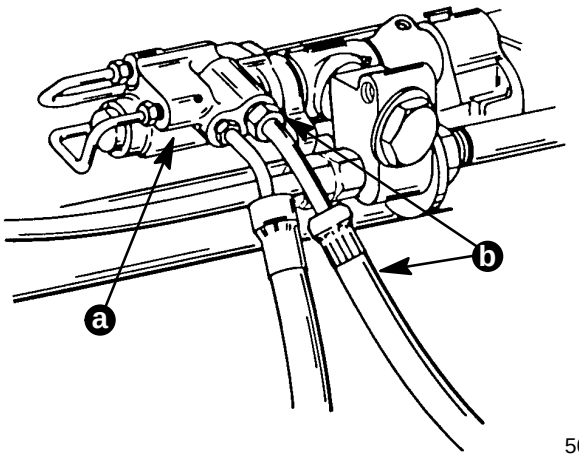
2. Remove hose where routed and secured across top of engine flywheel housing.



72853

a - J-Clamps

3. Remove large fitting from control valve at transom. Remove hose.



50912

a - Control Valve
b - Large Fitting and Hose

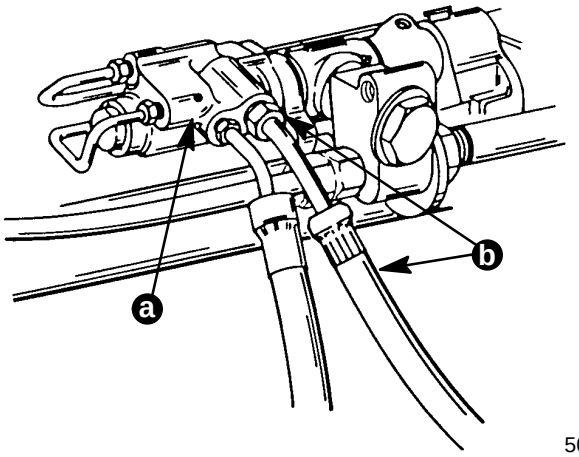
INSTALLATION

⚠CAUTION

Route hoses exactly as shown below. This will help avoid stress on the hose fittings and will help avoid kinks in the hoses.

IMPORTANT: Be careful to not cross-thread or over-tighten hose fittings.

1. Thread large fitting into control valve. Position hose properly (as prior to removal) and torque fitting to 20-25 lb. ft. (27-34 N·m). Do not cross-thread or over-tighten.

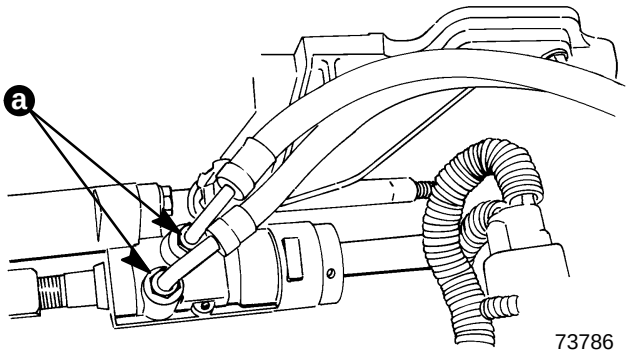


50912

Early Style

a - Control Valve
b - Large Fitting and Hose

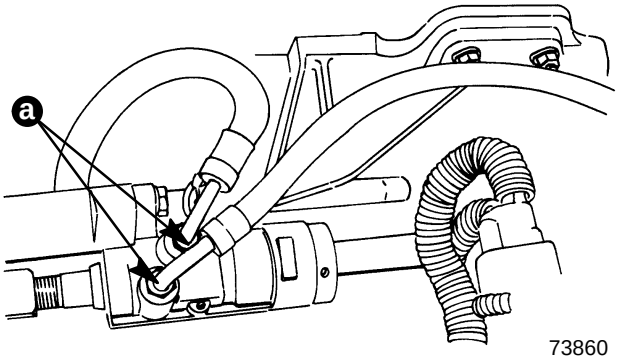
2. If equipped with later style control valve, install fittings and torque to 23 ft. in. (21 N·m).



73786

Later Style - All Models Except 502 Magnum EFI

c - Power Steering Hose Fittings



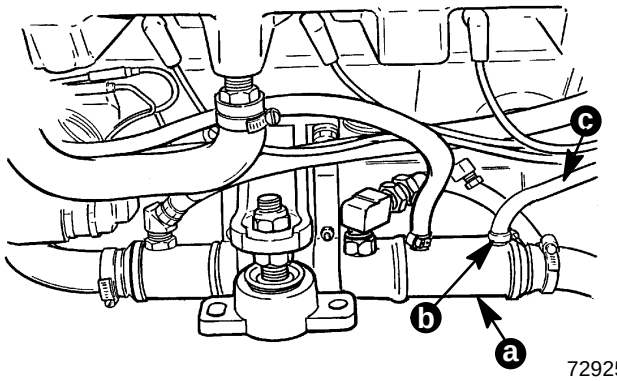
73860

Later Style - 502 Magnum EFI With return Lines On Starboard Side Power Steering Cooler

a - Power Steering Hose Fittings

IMPORTANT: Be careful to not cross-thread or over-tighten hose fittings.

3. Route hose along flywheel housing and secure with J-clamp(s) provided.
4. Using hose clamp, install hose on fluid cooler. Tighten clamp securely.



72925

a - Fluid Cooler
b - Hose Clamp
c - Hose

5. Fill and air bleed system. Refer to Section 1B - “Maintenance” (see “Table of Contents”).

Priority Valve Kit (79691A1) Information

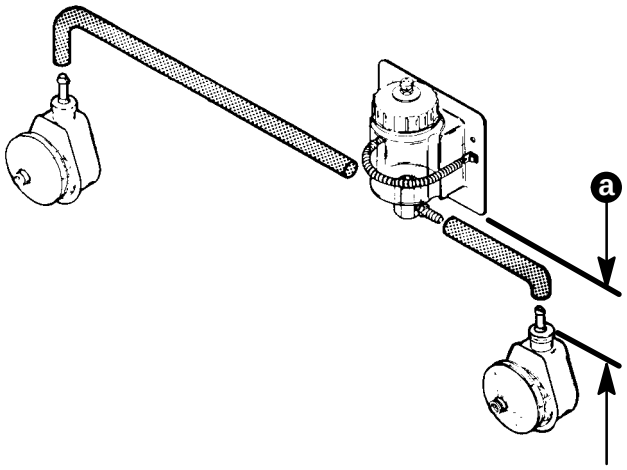
This kit information (in “Installation Instruction” form) is provided to assist personnel when servicing dual installations where both engines are equipped with power steering pumps, coolers, related hardware and hoses, and one transom assembly is equipped with power steering.

Although the system may already be installed, refer to appropriate sections and follow instructions that relate to your task when servicing those components.

NOTE: *A system flow diagram is located on the last page of this section.*

Installing Reservoir

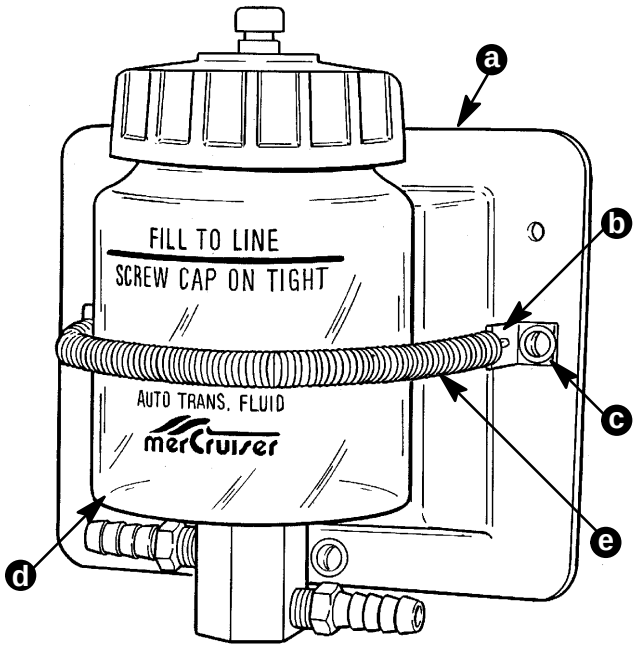
1. Mount reservoir bracket.
   a. Find a location between both power steering pumps that affords both accessibility and easy visual inspection of fluid level. Location must be at least 6 in. (152 mm) higher than pump cap to allow fluid from reservoir to flow freely to pumps (preferably on transom or on forward engine compartment wall).
   b. Install reservoir mounting bracket with hardware supplied.



71402

a - Measurement - 6 In. (152 mm) Minimum

2. Position bottle reservoir in mounting bracket and secure with retainer spring.



72854

a - Reservoir Bracket
b - Reservoir Spring Retainer Tab
c - Screw And Washer (Not Shown In This View)
d - Reservoir Bottle
e - Retainer Spring

IMPORTANT: A two-way valve is required on the reservoir cap for cold weather operation below 40°F (4°C).

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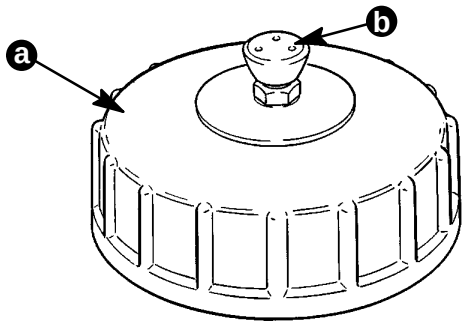
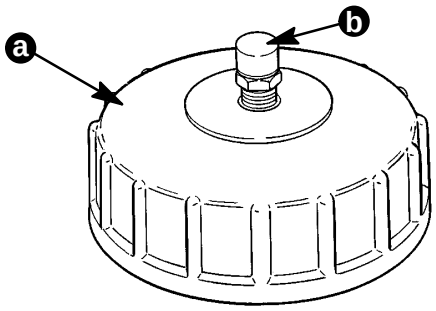
3. If required, install two-way valve in reservoir cap by removing vent from cover and replacing it with a two-way check valve.



72855

a - Reservoir Cap
b - Vent



72856

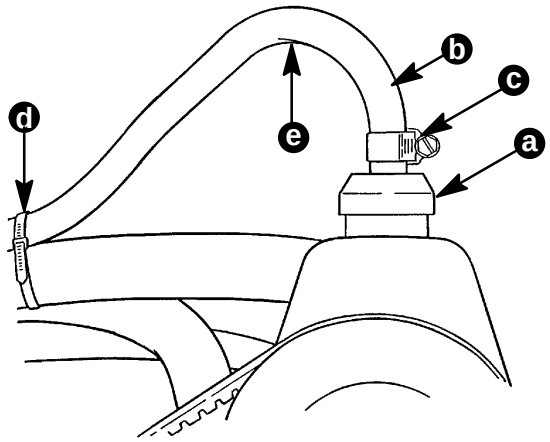
a - Reservoir Cap
b - Two-Way Valve (Installed)

4. Cut two hoses (from bulk hose supplied) of sufficient length to extend from bottom fittings on reservoir to fill caps on power steering pumps. Allow extra hose for routing.

IMPORTANT: When routing and installing hoses in the following steps, be sure that the bend radius in the hose is sufficient to eliminate a load being placed on power steering pump fill cap.

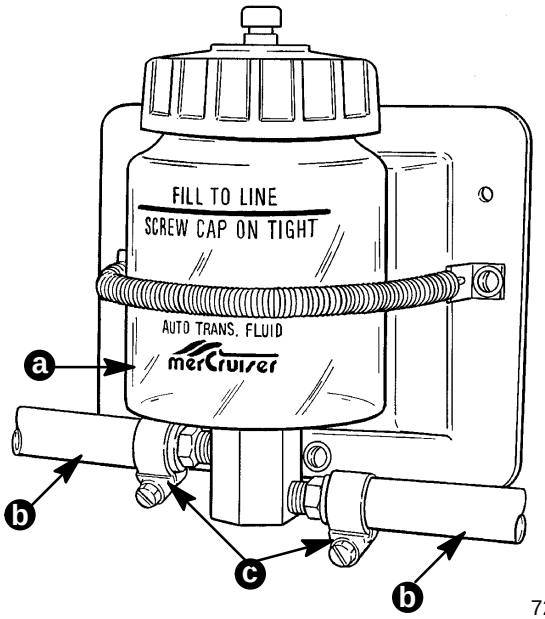
5. Connect hoses, that were just cut, to reservoir and power steering pump caps (from kit). Secure with hose clamps. Tighten securely.

6. Secure hoses with Sta-Straps to keep them below reservoir fluid level line and away from heat and moving parts.



72857

a - Power Steering Pump Cap (Port And Starboard)
b - Hose To Reservoir
c - Hose Clamp
d - Sta-Straps
e - Bend Radius (Port and Starboard)



72858

a - Reservoir
b - Hoses From Pumps
c - Hose Clamps

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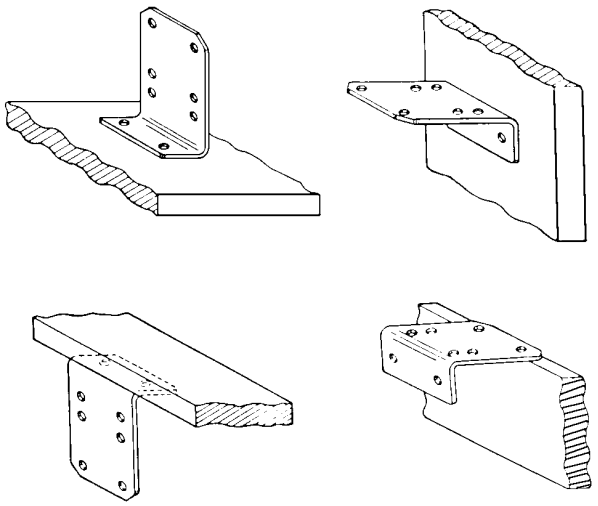
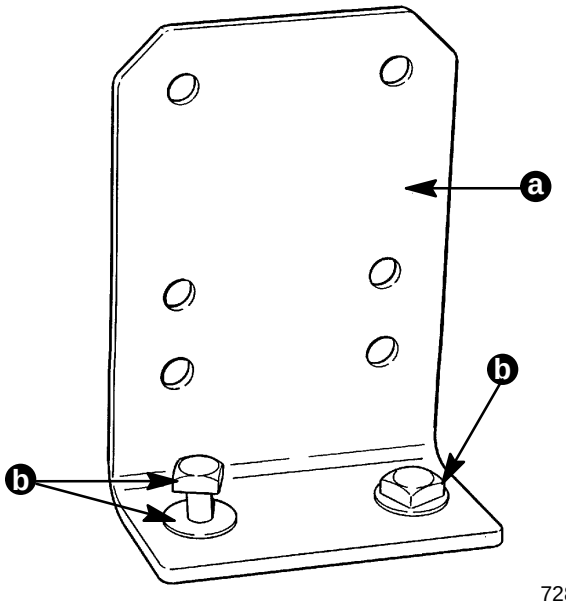
Installing Priority Valve

NOTE: *Priority valve mounting bracket can be used in various mounting configurations.*



71403

1. Install priority valve mounting bracket.
   a. Find a central location that will be accessible for making and checking hose connections. Ensure that location will allow 2 in. (51 mm) or more, above and below priority valve for hose connections and routing (preferably on a stringer near transom).
   b. Mount bracket using lag bolts and washers supplied.

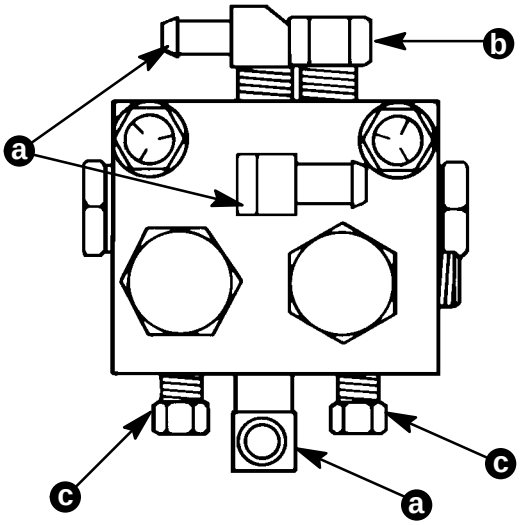


72859

a - Mounting Bracket
b - Lag Bolts and Washers

NOTE: *The 90° elbow locations on priority valve are marked with a "T" stamped into the valve.*

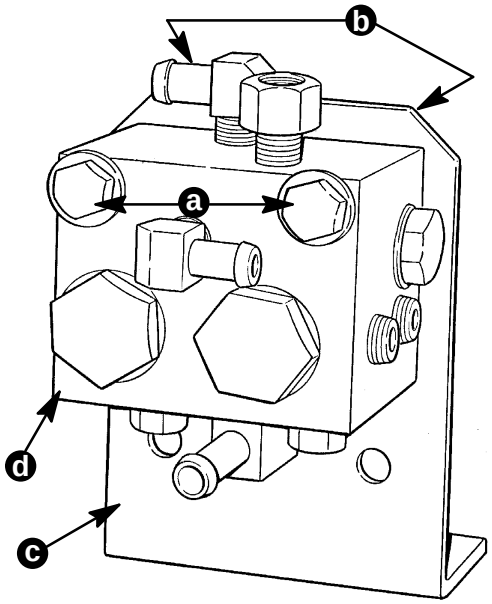
2. Apply liquid pipe joint sealer to threads and install fittings into priority valve.



71404

a - 90 Degree Elbow
b - Large Inverted Flare Fitting
c - Small Inverted Flare Fitting

3. Mount priority valve on bracket. Torque bolt to 120 lb. in. (14 N·m).



72860

a - Bolt and Washer
b - Washer and Nut (Not Shown In This View)
c - Bracket
d - Priority Valve

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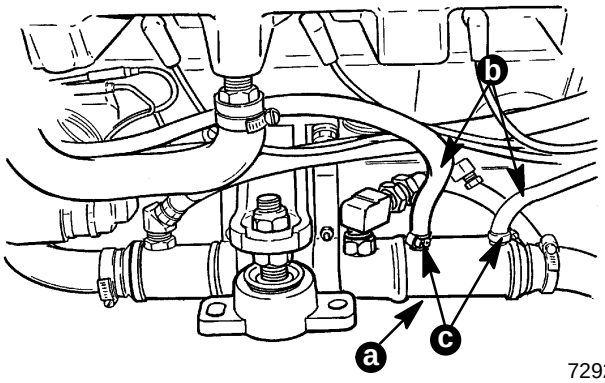
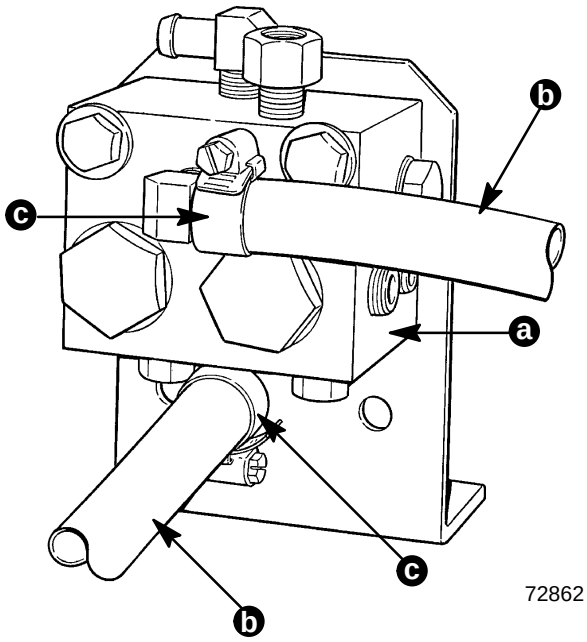
NOTE: *Engines with power steering are equipped with a hose that is connected to the power steering fluid cooler. A fitting on the other end of the hose would normally be connected to the power steering control valve. These hoses are not used and are replaced with bulk hose supplied with priority valve kit.*

4. Remove and discard old hoses which are connected to power steering cooler (port and starboard).
5. Cut two hoses (from bulk hose supplied) of sufficient length to extend from power steering coolers to respective fittings on priority valve.
6. Connect one end of each hose to its respective power steering fluid cooler and other ends to fittings on priority valve. Secure with hose clamps. Tighten securely.



72925

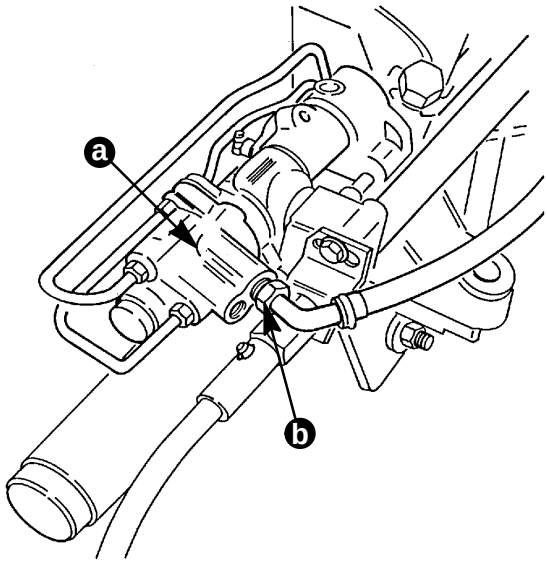
a - Power Steering Fluid Cooler
b - Hose
c - Hose Clamp



72862

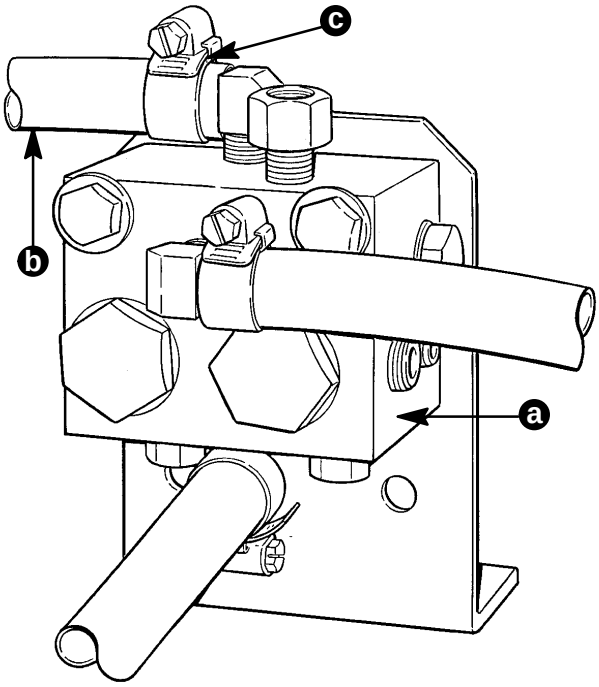
a - Priority Valve
b - Hose
c - Hose Clamp

7. Install return hose (large fitting on one end only, from kit) to power steering control valve. Route hose to priority valve, cut hose to length, and connect to fitting on priority valve. Secure with hose clamp. Tighten securely.



72863

a - Power Steering Control Valve
b - Hose Fitting



72864

a - Priority Valve
b - Hose
c - Hose Clamp

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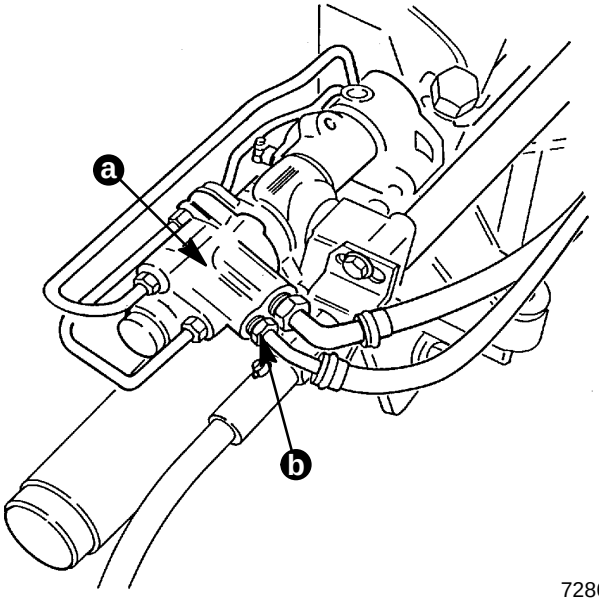
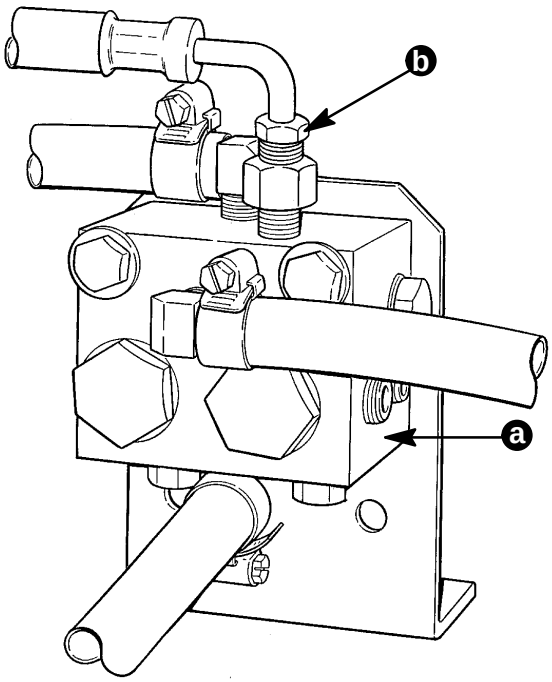
8. Install pressure hose (fittings on both ends, from kit) between power steering control valve and large inverted flare fitting on priority valve. (This fitting location is marked with an “S.”) Secure with hose clamp. Tighten securely.



72865

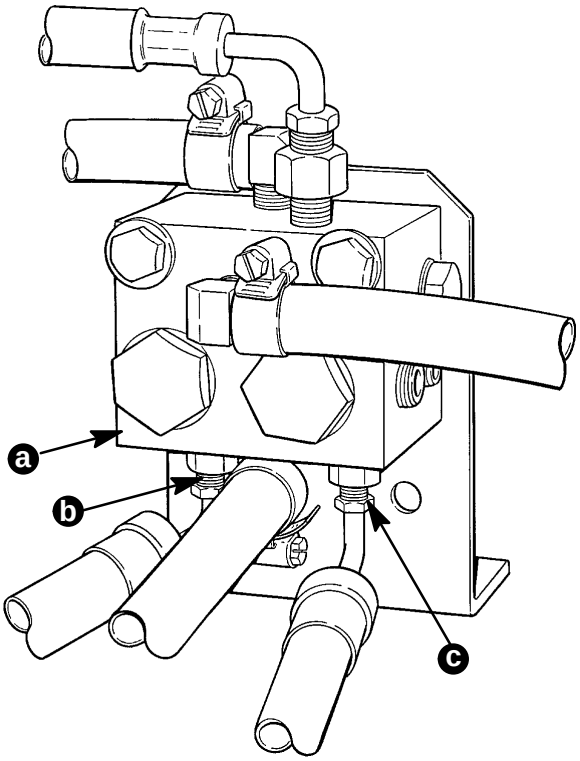
a - Power Steering Control Valve
b - Hose Fitting



72866

a - Priority Valve
b - Hose Fitting

9. Connect No. 1 (starboard) engine pressure hose (from pump) to inverted flare fitting marked by “1” on priority valve. Connect No. 2 (port) pressure hose (from pump) to inverted flare fitting marked by “2” on priority valve. Secure with hose clamps. Tighten securely.



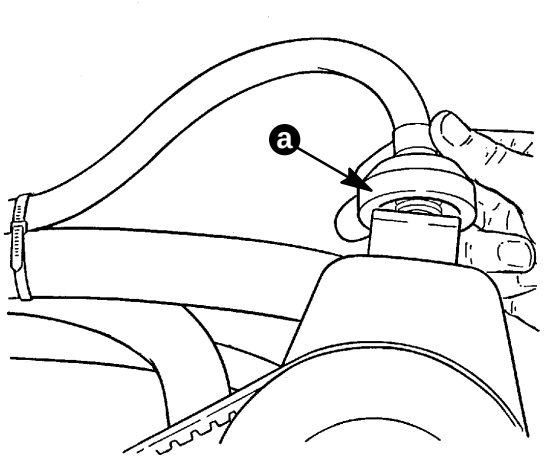
72867

a - Priority Valve
b - No. 1 (Starboard) Pressure Hose
c - No. 2 (Port) Pressure Hose

10. Secure all hoses with Sta-Straps provided.

Filling System with Fluid

1. Fill pump reservoirs with automatic transmission fluid (ATF) Dexron ll or Dexron lll.
2. Install and tighten pump cap by turning cap clockwise approximately 120 degrees.



72868

a - Cap

3. Fill reservoir bottle to full mark, then (one at a time) slightly loosen pump cap to allow fluid to flow from reservoir to pump until pump just starts to overflow, then quickly tighten pump cap. Fill bottle reservoir and repeat this process for the other pump.
4. Double check both caps to ensure they are both tight.

Maintenance

Maintenance inspection is the owner's responsibility and must be performed at the following intervals:

<u>Normal Service</u> - Every 50 hrs. of operation or 60 days (whichever comes first)

<u>Severe Service</u> - Every 25 hrs. of operation or 30 days (whichever comes first)

NOTE: *Operation in salt water is considered severe service.*

1. Check all connections and hose clamps for adequate tightness. Tighten, if loose.
2. Check all mounting bolts and tighten if necessary.
3. Be sure to check reservoir oil level periodically.

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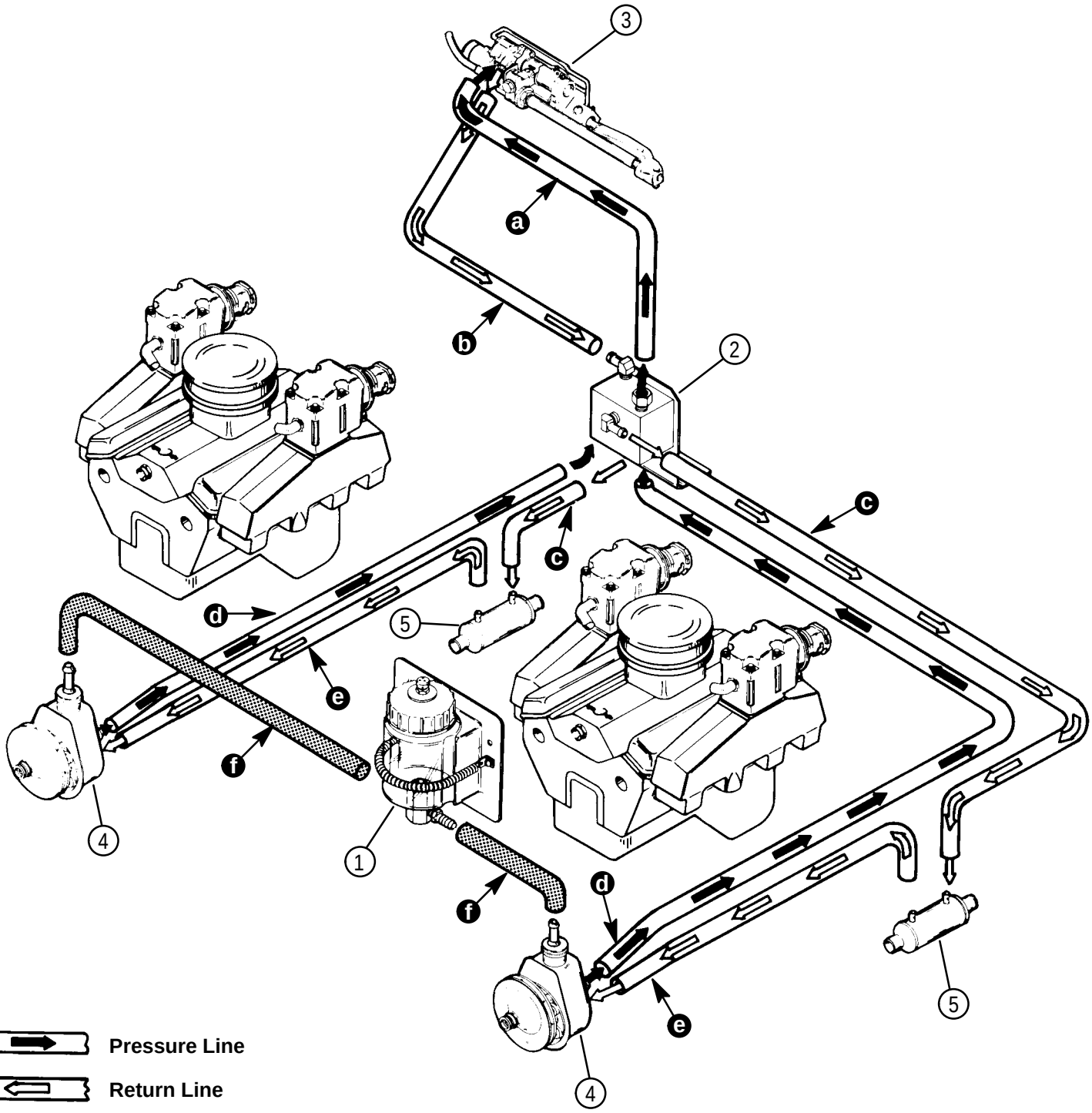
System Flow Diagram (Typical)



Pressure Line

Return Line

Gravity Feed Line

71405

1 - Reservoir Bottle and Bracket
2 - Priority Valve and Mounting Bracket
3 - Power Steering Control Valve
4 - Power Steering Pump
5 - Power Steering Fluid Cooler

a - Pressure Hose (Fitting on Both Ends - Supplied in Kit)
b - Return Hose (Fitting on One End - Supplied in Kit)
c - Return Hose from Pump (Cut from Bulk Hose Supplied)
d - Pressure Hose from Pump
e - Return Hose from Pump
f - Gravity Feed Hose (Cut from Bulk Hose Supplied)

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THIS PAGE IS INTENTIONALLY BLANK TO ALLOW FOR CORRECTIONS OR ADDITIONS AT A LATER DATE